WATER & SEWAGE WORKS

WATER SUPPLY • SEWAGE DISPOSAL

UNIVERSITY MICROFILMS
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ANN ARBOR, MICH.
COMP

Water and Sewage Service in Housing Developments

Separated by a lagoon, central sewage treatment and water supply are provided in this Florida project

FEBRUARY 1956

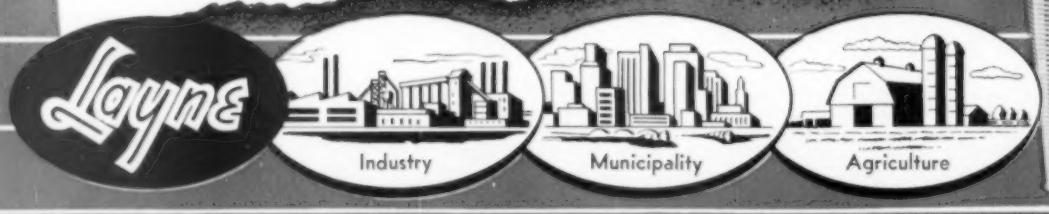
Rhinelander, Wisconsin
...Relies on Layne!

An imaginary monster, the "Hodag," brought fame to Rhinelander, Wisconsin, and this charming smaller city is known as "the Home of the Hodag." Born at the time of the logging boom, Rhinelander today is a tourist and industrial center.

Smaller municipalities such as Rhinelander, as well as the great metropolitan centers of the nation, know that utmost dependability in pumps is spelled L-A-Y-N-E. That's why Rhinelander relies on Layne.

LAYNE
& BOWLER, INC.
MEMPHIS
General Offices and Factory

LAYNE ASSOCIATE COMPANIES THROUGHOUT THE WORLD



Water Wells • Vertical Turbine Pumps • Water Treatment

For Trouble-Free Service, Infiltration-Proof Joints

COLUMBIA, MO.

Specifies

CLAY PIPE

COLUMBIA, MISSOURI'S latest municipal sewerage improvement project called for more than 42,000 feet of 24 inch to 36-inch Vitrified Clay Pipe. A large section of the project is located in the city's attractive university district, where officials are especially interested in avoiding unsightly repair jobs in the years ahead. Other parts of the line were laid adjacent to a creek, making leak-proof, infiltration-proof joints a "must." With these requirements in mind, officials in charge of the project specified Vitrified Clay Pipe . . . the *only* pipe that never wears out. A wide variety of new jointing methods, developed through industry-wide research, insure *absolutely tight* lines—even in high-water-table areas. For *permanent* service, always specify and install Clay Pipe. *It's guaranteed for half a century.*

FOR COLUMBIA, MO.—S. E. Grundler, City Engineer

CONSULTING ENGINEERS—Black and Veatch, Kansas City, Mo.

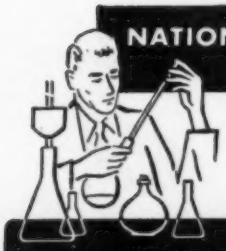
CONTRACTORS: B & G Construction Company, Carthage, Mo., Supt. Roy E. Fuller, and Foreman Lewis Dye.

Vitrified

CLAY PIPE NEVER WEARS OUT!

PIPE

C-156-1



NATIONAL CLAY PIPE MANUFACTURERS, INC.
1820 N. Street, N.W., Washington 6, D. C.

206 Connally Bldg., Atlanta 3, Ga.
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Progress in Public Health - Through Clay Pipe Research

CAST TO LAST 100 YEARS

The name "CLOW" cast on the face of cast iron pipe is your guarantee of high quality. This distinctive "autograph" marks the precise, modern production methods and the advanced, exacting control of metallurgical quality employed by Clow to assure you the finest cast iron pipe.

Four generations of waterworks operators and municipal officials have looked to Clow for high quality and good service. Clow cast iron pipe exceeds the physical requirements of all currently approved specifications. We would welcome the opportunity to serve you.

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201-299 North Talman Avenue • Chicago 80, Illinois

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WATER AND SEWAGE WORKS, Reg. U. S. Patent Off. Published monthly by Scranton Publishing Co., at 5th and Ferry St., Lafayette, Ind. Entered as second class matter at the post office at Lafayette, Ind., under Act of March 3, 1879.

SINCE
1861

LUDLOW

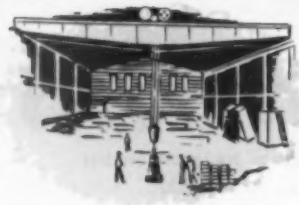
How the consolidation of **two great valve companies** can help you

In January, 1955, two great valve companies consolidated their resources. They had been neighbors in Troy, New York and friendly competitors for two thirds of a Century. The names remain the same but Rensselaer became a Division of The Ludlow Valve Manufacturing Company — All now under one management in one plant, with unit responsibility to its customers.

THE BEST IN DESIGN

You, the Water Works Executives are the final judges. You have cast your ballots in the form of extensive purchases over the last half century. In many cases the result is obvious, but your opinions on A.W.W.A. valves and hydrants vary. Therefor both lines will be continued and any Representative of the combined companies can show you the characteristics of each. In the meantime our search for ever-better valves goes on.

THE BEST IN PRODUCTION



The production facilities of the combined Companies have been consolidated and at the same time are being greatly expanded. Only the newest, most modern equipment has been retained. Hundreds of thousands of dollars worth of new equipment is expanding the capacity and giving even greater assurance of our ability to serve. This means insurance for you, more local stocks to draw on, and shorter deliveries on heavy equipment. This all means lower inventories for you.

THE LUDLOW
VALVE MFG. CO., INC. TROY, N.Y.

TRADE LUDLOW MARK

GATE VALVES • FIRE HYDRANTS • SQUARE BOTTOM VALVES
CHECK VALVES • TAPPING SLEEVES • AIR RELEASE VALVES

SINCE

—Rensselaer 1885

THE BEST IN EXPERIENCE

The combined Companies have had experienced engineers in the field in every State of the Union for a total of 165 years of service. These men have helped you, you have helped them, and in turn they have helped many others. The results of this close contact over a long period have been reported back and catalogued to become an up-to-date "Encyclopedia" for the Water Works field.

THE BEST IN SALES ENGINEERING

Sales Engineering in the field backed by the extensive fund of knowledge in the home office is the art of locating the right product in the right place at the right time, with the lowest possible cost and installation time. In most cases an error in the original selection can cost far more in digging, flooding or stoppages, than the original equipment. In other cases, the sales engineer may make important savings in the installation cost. The Ludlow and Rensselaer Sales Engineers and the "Encyclopedia" are at your service.

AND THE TRADITIONS GO ON

The names, Ludlow and Rensselaer mean the same today that they have during your lifetime. The desire to serve the Water Works Field in person —in research and design and in prompt delivery of original equipment and spare parts for all products has not changed. On the other hand, our ability to serve has at least doubled.

We shall appreciate the opportunity to explain in person what all of this means to you.

Bulletins available on all equipment, replacement parts and accessories.

Rensselaer VALVE CO.

TROY, NEW YORK

DIVISION OF THE LUDLOW VALVE MANUFACTURING CO., INC.

GATE VALVES • FIRE HYDRANTS • SQUARE BOTTOM VALVES
CHECK VALVES • TAPPING SLEEVES • AIR RELEASE VALVES

Utilities pipeline contractor

Averages 20 feet of trench per minute, digs 2 to 4 jobs per day with each of his Clevelands

1000 feet of complete pipeline construction—trench digging, pipelaying, backfilling and backfill compaction—is an average day's work for each crew of F. H. Linneman, Inc., pipeline and utilities contractor of Denver. Most of this work is on 2-, 4- and 6-inch pipelines for the many new housing developments in the Denver area.

With a Cleveland Trencher opening up trench at an average rate of 20 feet per minute, a typical Linneman crew will do 2, 3 or 4 complete pipeline jobs in an 8-hour day—jobs that run from 50 to 1000 feet each in length. One of these crews has a record day's production of 7 complete jobs.

Currently operating 7 Cleveland Trenchers, Linneman specializes in utilities work—gas, water and sewer line construction. Equipment-minded and especially maintenance-conscious, he has consistently employed Clevelands ever since he began his contracting business in 1946.

Fast portability of equipment is essential in Linneman's tight-scheduled operations. His Clevelands can be loaded on their low-bed trailers in less than 10 minutes time, ready to roll safely from job to job at legal limit speeds.

"Maintenance costs on Clevelands are appreciably lower" says owner of 7

Here is what F. H. Linneman has to say about trenchers:

"In the type of work we most generally perform, in the city especially, we have found Clevelands best suited to our operations because of their narrow-width construction, compactness and speed. They enable us to work in close places and keep trenching ahead of follow-up operations, a decided advantage.

"We have employed Clevelands in our work since we began contracting in 1946. We have seven of them at the present time, the oldest being a Cleveland Model 95 purchased in 1948. We have no record of the miles this machine has dug, but feel that it would be a near-record. Our maintenance costs on it have been extremely low.

"Our over-all maintenance costs on Clevelands are appreciably lower than on other trenchers we have operated. This is another reason why we have purchased more Clevelands than any other make. We have also found it easier to train operators for Clevelands than for any other make. Our newest Cleveland, a "240," was delivered only last week by H. W. Moore Equipment Co., here in Denver."

THE CLEVELAND TRENCHER COMPANY • 20100 St. Clair Ave. Cleveland 17, Ohio

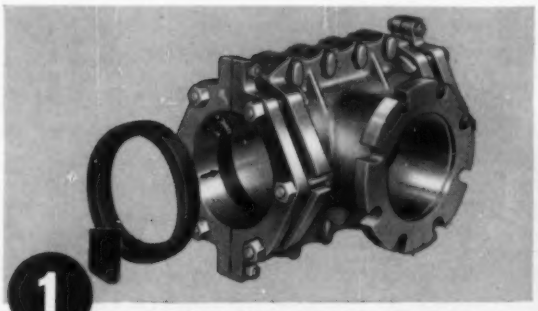
CLEVELAND

For tapping mains under pressure

THE *EDDY* WAY

IS THE EASY WAY

faster, simpler, too!



1

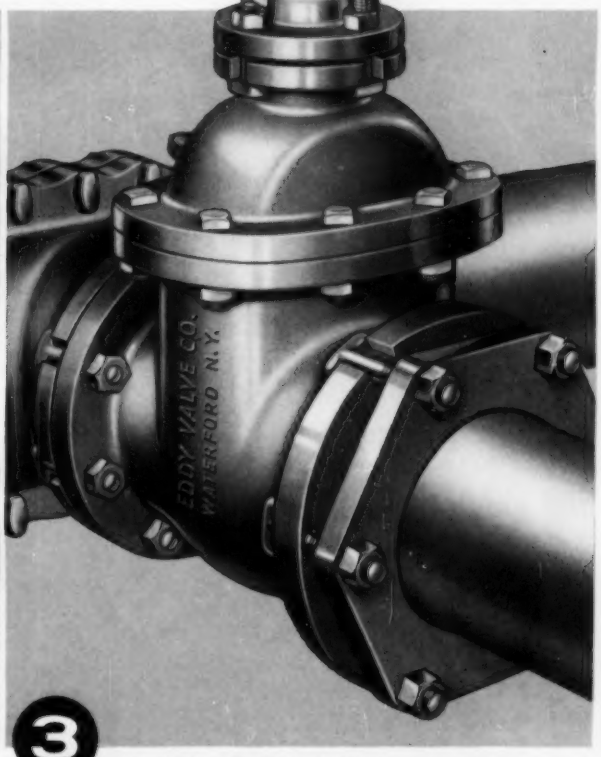
Strength To Withstand Tapping Strain

The extra length and heavy-duty, ribbed construction give strength to withstand strain of the tapping operation. Helical spring in gasket prevents extrusion between pipe and sleeve. Always a tight, permanent seal!

2

Fits All Pipe—Assembles In Minutes

Specially designed, armored gasket seals end flanges . . . and fits either AWWA or centrifugally cast pipe diameters. One man can assemble the Eddy Mechanical Joint Sleeve in minutes . . . even in a wet trench . . . with only a ratchet wrench. Tee-head bolts fit in notched flange . . . can't slip or turn when assembling.



3

And After The Tap Is Made . . .

. . . the standardized mechanical joint of the Eddy Tapping Valve permits fast assembly of the pipe for the branch line. Eddy Mechanical Joint Tapping Valves offer the same rugged, quality construction of *all* Eddy AWWA valves . . . that give years and years of dependable service.

EDDY mechanical joint tapping valves and sleeves

No Service Interruptions When You Connect Branch Mains the Easy, EDDY Way

Here's the most practical . . . and economical . . . way to connect branch mains. So simple even unskilled labor can do it right . . . every time. So sure you needn't ever worry about interrupting water service . . . no need closing valves to shut off mains . . . no bother to users.

Both sleeves and valves in sizes 4 inches through 12 inches.

EDDY VALVE COMPANY

A Subsidiary of James B. Clow & Sons, Inc.

WATERFORD, NEW YORK

IT KEEPS YOU
but for a

MODERNIZED cast iron

AWAKE, TOO... different reason

To the householder, a dripping faucet is only an annoyance . . .

To you it's waste that can be eliminated only by an educated and alert public, willing to cooperate in your efforts at conservation.

Here, we can . . . and will continue to . . . help.

Our national advertising campaign, reaching millions, stresses conservation and the need of long-range, advance planning for adequate water facilities. It urges realistic water rates and support for the forward-looking legislation and bond issues that will insure a plentiful supply for the future.

It's designed to help America . . . and you . . . conserve our most precious national resource . . . keep water flowing freely and abundantly for all.

CAST IRON . . . the pipe that's bought on proof, not claims

No other pipe can point to so convincing a record of long life.

Over 70 public utilities are served by cast iron mains laid over a century ago. This demonstrated record of long life not only gives the public the dependability it has a right to expect in a water system . . . it saves tax dollars as well. Once in the ground, cast iron serves for generations with minimum maintenance. Cast iron's long term economy pays off!

Today, water officials can rely on even better cast iron pipe. Modernized cast iron pipe, centrifugally cast, is tougher, stronger, more uniform. And where needed and specified it is cement-lined to assure sustained carrying capacity throughout its long service.

You specify wisely and well when you specify cast iron pipe for your water system. The experience of over 100 years proves you chose the best.

Cast Iron Pipe Research Association, Thos. F. Wolfe, Managing Director, 122 So. Michigan Ave., Chicago 3, Illinois.

Laid 120 years ago this cast iron water main continues to serve the taxpayers of Lancaster, Pa. Photo shows section of a line about 1½ miles long, laid in 1836, and still a part of the Lancaster water distribution system.

CAST IRON

The Q-Check stencilled on pipe is the Registered Service Mark of the Cast Iron Pipe Research Association.

pipe FOR MODERN WATER WORKS

FAIRFAX, VIRGINIA. Steel standpipe, 900,000 gallons capacity. Diameter 48 ft., head range 67 ft.

Where natural elevations are available, **choose**

PITTSBURGH ·DES MOINES

Steel Reservoirs and *Standpipes*

for maximum economy in better water supply

OTTUMWA, IOWA. Steel reservoir, 4,200,000 gallons capacity. Diameter 110 ft., head range 60 ft. 4 in.

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ST. PAUL, MINNESOTA. Steel reservoir, 2,000,000 gallons capacity. Diameter 70 ft., head range 70 ft.

The strength, endurance and low cost of Pittsburgh-Des Moines All-Steel Reservoirs and Standpipes meet every requirement of service and economy wherever terrain is advantageous. A wide range of standard and special designs is available, fabricated and erected with skill and experience. *Let us quote on your projected needs.*

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Water is vital...

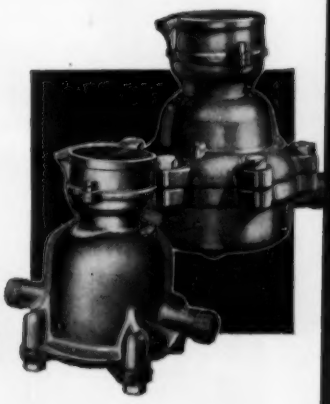
Badger meters conserve it better!

THEY say oil and water do not mix — yet the oil industry uses more than 1600 billion gallons of water annually for refining petroleum. And *nearly 40% of the water used is furnished by public water systems.*

To pinpoint this tremendous volume—more than 4 gallons of water are used in the production of one quart of oil for your automobile.

The Badger water meters used throughout the nation help conserve water for this need . . . just as they do for hundreds of other essential industries and for vital home usage. They measure water accurately . . . provide a precise check on water consumption and waste . . . serving communities by helping make water departments more efficient and self-supporting.

As the experience of waterworks men everywhere shows, Badger meters do the job dependably . . . are a sound investment that pays dividends year after year.



Badger Water Meters

Badger Meter Mfg. Co.
Milwaukee 45, Wisconsin

"Measuring the water of the world for 50 years"

Working Beauty at Cincinnati

The striking modern design and operational capabilities of this Hortonspheroidal® elevated water tank, provide a real working beauty for the Western Hills section of Cincinnati, Ohio. The 2,500,000-gal. elevated tank not only solved water distribution problems caused by peak load demands, but also blends attractively with the surrounding landscape.

To learn how a Horton® elevated tank can improve your municipal water service and enhance your city's appearance, write our nearest office for complete information.

CBI

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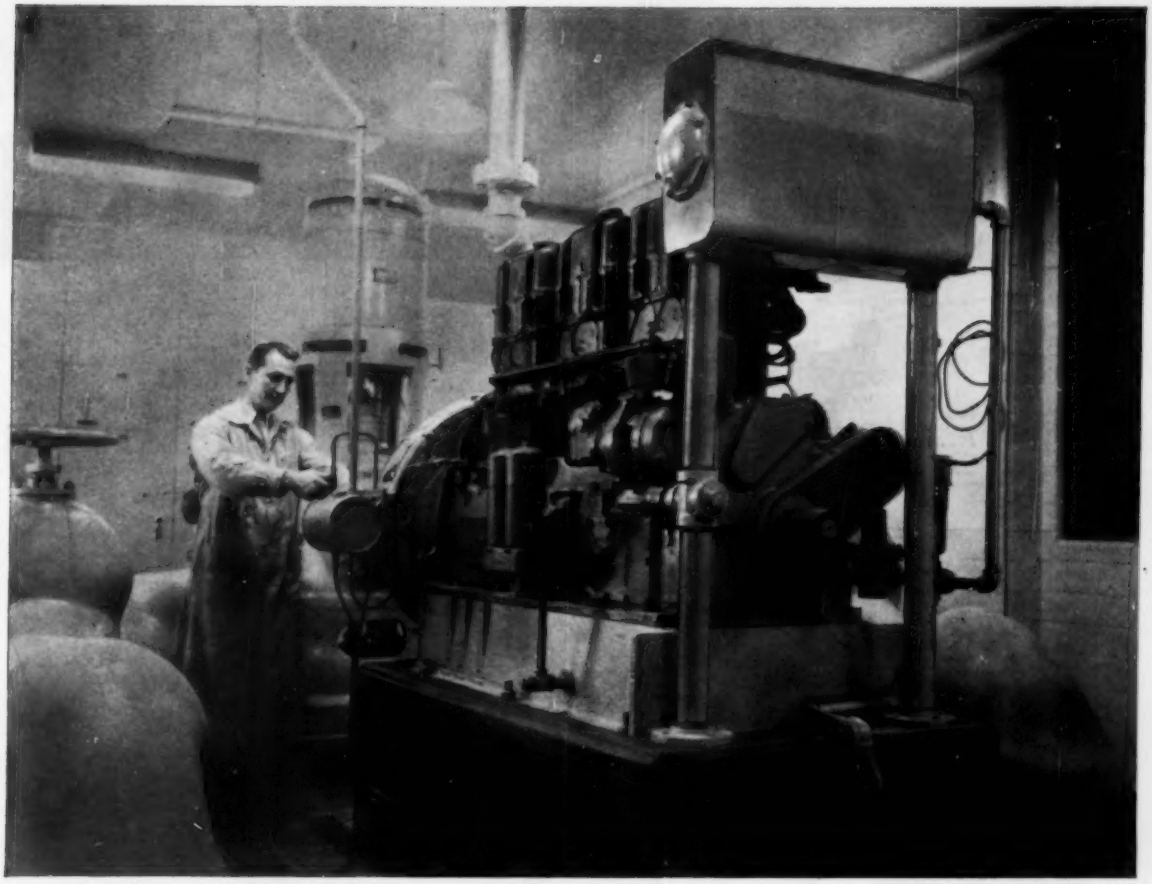
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PA.



Standby...for Action

... the dependability built into Le Roi engines means that you have power when you need it most

The operator of the Le Roi F1500 shown above said, "This engine has surpassed our every requirement for standby power, and has more than paid for itself with dependable, economical, power production when we needed it most."

That's typical of the results experienced by Le Roi engine users everywhere. But you get more than just dependability. You get economy.

For example, Le Roi engines are so compact that you save on installation costs. Volume production and post-war designs give you more horsepower per dollar. Also, because Le Roi engines can use the lowest cost fuels available, savings in operating costs are important, too. We have some engines that have saved taxpayers over $4000 a year for 14 years — others that have saved $7600 in a 10-month period. And so it goes.

You, too, can save your taxpayers' money and still provide them with the services they need, by using Le Roi engines. Sizes range up to 645 hp, or in custom generator sets from 50 to 350 KW. And all Le Roi's operate on natural gas, LPG, gasoline, or no-cost sewage gas. Write us for our latest literature.

E-108

LE ROI *Division of Westinghouse Air Brake Co.*

Milwaukee 1, Wisconsin

PORTABLE AIR COMPRESSORS

TRACTAIR

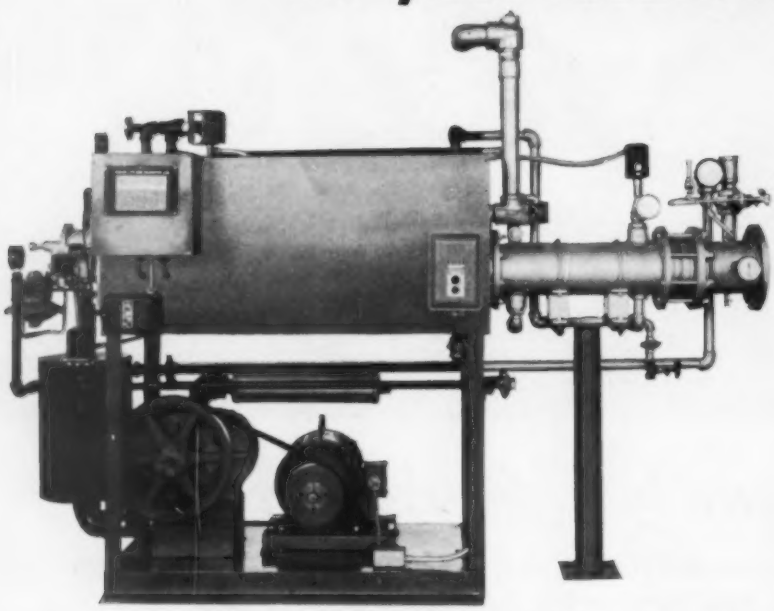
STATIONARY AIR COMPRESSORS

AIR TOOLS

ENGINES

50% MORE CO_2

for your recarbonation basin



with the

WALKER PROCESS Carball CO_2 unit

The specially designed CARBALL burners, using gas or oil, produce up to 50% more CO_2 per unit of fuel. Complete combustion of the fuel and air mixture is attained by 100% burner efficiency . . . producing *all* available CO_2.

Combustion is performed at extremely high temperatures which completely eliminates condensable carbon and other objectionable by-products and provides a clean, tasteless CO_2 gas which requires no scrubbing.

Compressing clean, cool air and charging it into the pressurized CARBALL combustion chamber prevents hot corrosive gas troubles commonly found in older systems.

Request bulletins 7W83 for complete details of the CARBALL and 7W85 for discussion and charts dealing with the mechanics of recarbonation.

WALKER PROCESS

WALKER PROCESS EQUIPMENT INC.

Factory - Engineering Offices - Laboratories
Aurora, Illinois

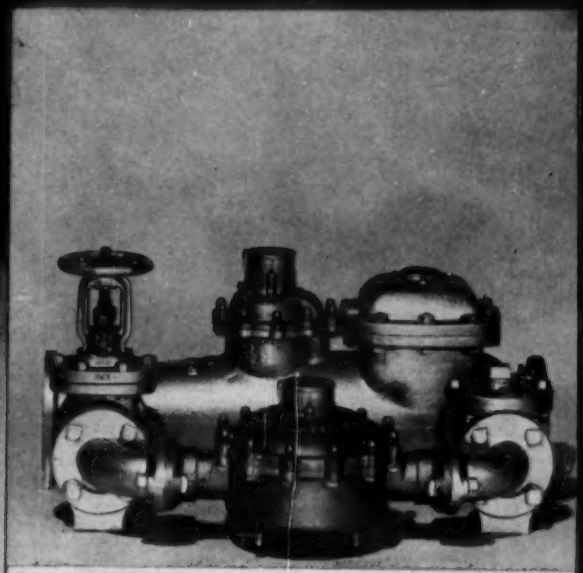
Prevent loss of revenue. Equip industrial fire services with

HERSEY DETECTOR (Fire Service) METERS

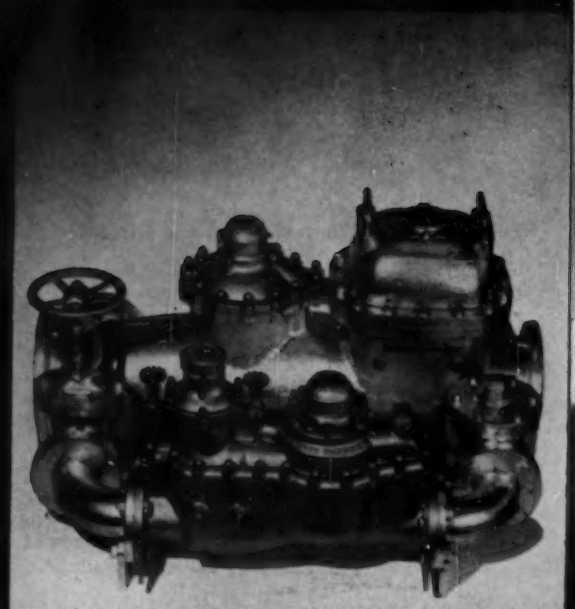
For detailed information, contact our nearest branch or write Main Office.

Listed by the Underwriters Laboratories, Inc. and the Underwriters Laboratories of Canada.

Approved by the Factory Mutual Laboratories.



HERSEY DETECTOR (Fire Service) METER with DISC METER on the BY-PASS



HERSEY DETECTOR (Fire Service) METER with HERSEY BRONZE CASE COMPOUND METER on the BY-PASS

HERSEY MANUFACTURING COMPANY

SOUTH BOSTON, MASS.

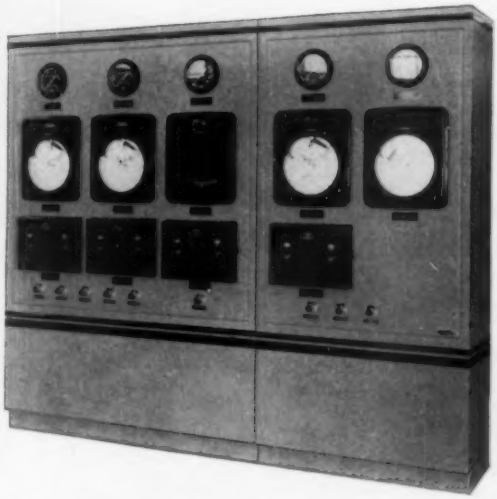
BRANCH OFFICES: NEW YORK — PORTLAND, ORE.
PHILADELPHIA — ATLANTA — DALLAS — CHICAGO
SAN FRANCISCO — LOS ANGELES

Completely Modern . . . Completely Controlled . . .

with Foxboro Automatic Control for Rapid Sand Filters

This trim, new municipal water treatment plant at Fairfield, Cal., is ultra-modern inside and out. Automatic control of the plant's four rapid sand filters is handled by the highly flexible Foxboro System shown in the accompanying illustrations. *Contractor: C. Norman Peterson, Co., Berkeley, Cal. Consulting Engineers: Solano Engineers Associated, Vallejo, Cal.*

Supt. Charles A. Crane turns "finger-tip" control selector switch on one of four Foxboro Master Operating Tables at Fairfield plant. Using switch, he can shut off influent or by-pass effluent to waste; start filtration or backwashing at pre-set rates. In addition, he can re-set rates at any time, without moving from table. Operating table is integrated with automatic control cabinet (right) to provide high versatility . . . maximum ease of operation.



Five instruments across center, l. to r., are recording and integrating — or controlling — influent and effluent flows, clearwell level, backwash rate, and effluent temperature. Timers (beneath) operate with influent flow recorder to proportion chemicals to influent.

Clean-cut, all-pneumatic operation of Foxboro Automatic Control for Rapid Sand Filters pays off in lowest cost installation, minimum maintenance, and greatest convenience. It's unaffected by backwash and sand . . . requires no drum, pulley, or cable servicing. Rugged d/p Cell Transmitters handle loss-of-head and filter rate measurements. Long-life, rubber-lined butterfly valves assure positive shut-off action.

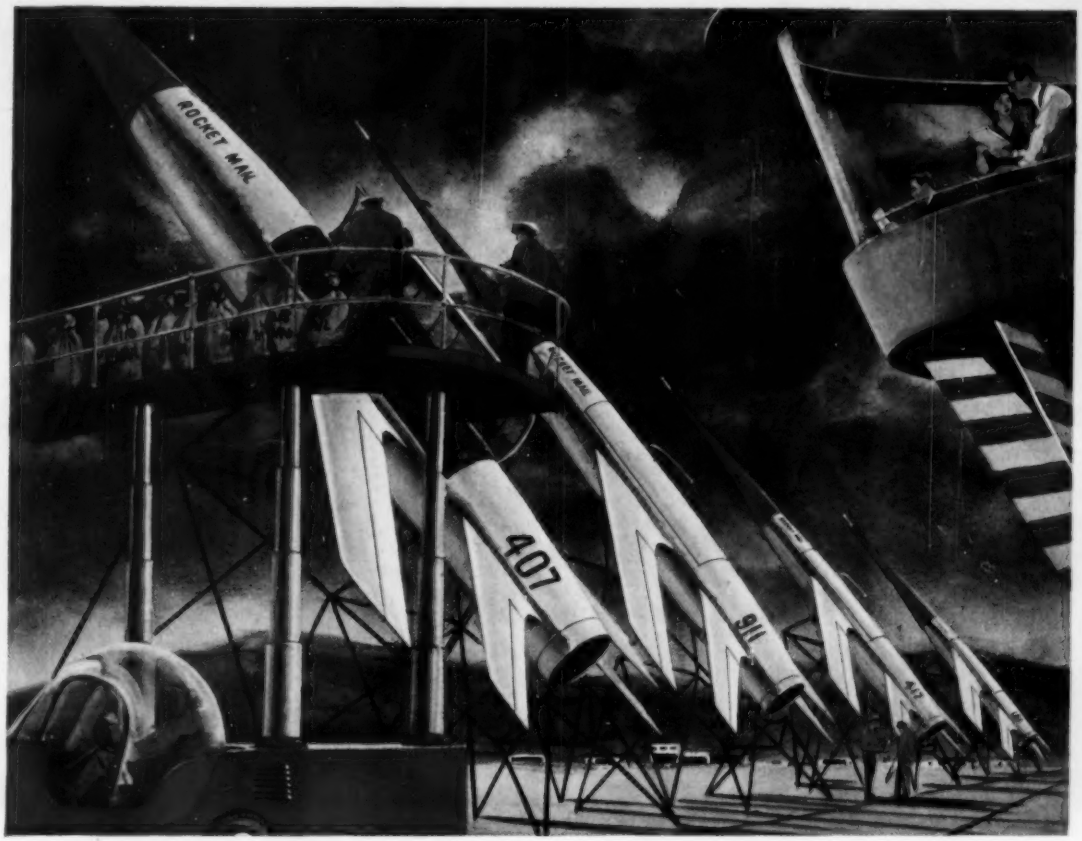
For full details on the economy *and* convenience of this modern system, write for illustrated Bulletin.

THE FOXBORO COMPANY, 892 NEPONSET AVE., FOXBORO, MASSACHUSETTS, U.S.A.

FOXBORO
REG. U.S. PAT. OFF.

AUTOMATIC CONTROL for RAPID SAND FILTERS

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND



RADAR controlled and guided, high speed rockets streaking through the stratosphere may deliver New York mail to San Francisco in less than an hour!

100 years from now...

WE MAY SEND MAIL BY ROCKET!

A century from now a wonderful, exciting and different world. But there will be one familiar note. The cast iron pipe laid today will still be carrying water and gas to the homes and industries of tomorrow.

In over 60 American cities, these dependable cast iron water and gas mains, laid more than a century ago, are still serving efficiently. And modernized cast iron pipe, centrifugally cast, is even stronger, tougher, more durable.

U. S. Pipe is proud to be one of the leaders in a forward-looking industry whose service to the world is measured in centuries.

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PIPE
FOR WATER, GAS, SEWERAGE AND INDUSTRIAL SERVICE
CAST IRON

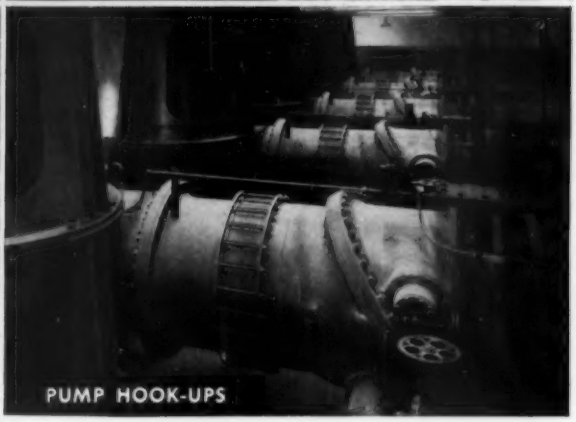
U. S. PIPE AND FOUNDRY COMPANY, General Office: Birmingham 2, Alabama

A WHOLLY INTEGRATED PRODUCER FROM MINES AND BLAST FURNACES TO FINISHED PIPE.

AIR LINES

DIGESTER TANKS

FORCE MAINS


PUMP HOOK-UPS

For any sewerage pipe job . . .

DRESSER COUPLINGS make joining easier, surer!

Every sewerage job presents individual piping problems: cramped space, heavy vibration, tight deflections and so on.

That's why the versatility of Dresser Couplings is so important. Using this joining method, contractors can handle *any* job . . . hit estimates and completion dates on the nose . . . provide work that gives permanent satisfaction.

Wrench installed, Dresser Couplings and Compression Fittings go on quickly, simply. There's no need for flanging, welding, caulking or other operations that run up costs and slow down jobs.

Moreover, factory-made Dresser joints eliminate exact pipe fitting and alignment. Their strong, resilient rubber gaskets absorb vibration and expansion-contraction movements. Easy to join, they're also easy to disassemble when installations need servicing or relocation. Leakproof, maintenance-free performance is assured for the life of the line!

See your piping supplier today on how you can save on sewerage and water projects.

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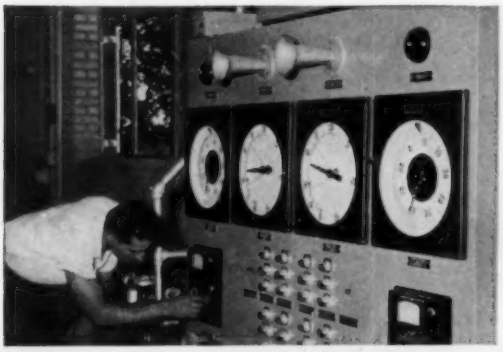
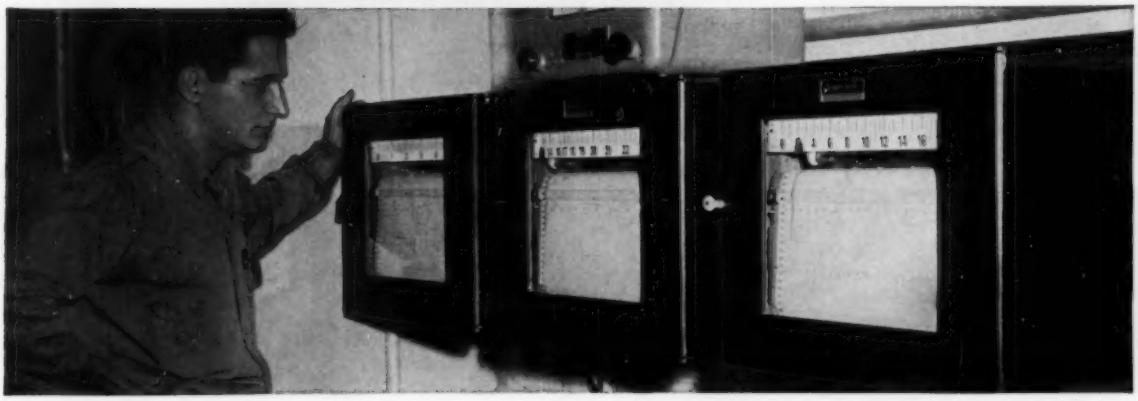
Dresser Manufacturing Division, 69 Fisher Ave., Bradford, Pa. Warehouses: 1121 Rothwell St., Houston; 101 S. Airport Blvd., S. San Francisco. Sales Offices also in: New York, Philadelphia, Chicago, Denver. In Canada: Toronto and Calgary.



*Incinerator operation at a glance—at Philadelphia's Bartram Plant, **ElectroniK** instruments in the furnace room (at left) automatically control burners, fans and louvres . . . and (below) tell Superintendent J. Faraldo exactly what values of smoke density and temperatures are being maintained.*



New Philadelphia incinerator plants maintain efficiency with *ElectroniK* instruments

The most modern of control techniques are incorporated in the group of new incinerators, ordered as an important part of Philadelphia's $6½ million waste disposal campaign. The Monohearth units, made by Nichols Engineering and Research Corp., are equipped with *ElectroniK* instruments that help to make operation highly automatic and efficient.

In the furnace room, operators have instant control over each variable essential to smokeless, odorless combustion.

ElectroniK instruments indicate smoke density and temperatures in stacks and combustion chambers, regulate furnaces within desired limits of operation. They automatically shut down forced-draft fans, light up auxiliary oil burners, open and close overfire louvres, and turn on water sprays in the fly ash eliminator. Whenever smoke density or temperatures exceed preset limits, the instruments actuate alarms to notify the operator. The plant superintendent, too, can see furnace operation at a glance, by means of other *ElectroniK* instruments in the plant office, which give him easily-read, continuous records of critical temperatures and smoke densities.

When you plan new incinerators or other expansion of waste disposal facilities, have your city engineer or consulting engineer call Honeywell before plans and specifications reach the final stage. Your local Honeywell sales engineer is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

Placing an 8-ft. long section of 96-in. diameter reinforced concrete pipe in a culvert structure for Moccasin Kill under the New York Thruway in Schenectady County at Rotterdam Junction.

Backfilling operations on the completed portion of a 21-in. concrete pipe drainage system for the Mohawk section of the New York Thruway in Schenectady County near Rotterdam.

Culverts and Drainage on New York Thruway require over 175 miles of *CONCRETE PIPE*

The longest express highway ever built—the 427-mile New York Thruway—reaches northward from New York City to Albany, then westward past Schenectady, Utica, Syracuse and Rochester to Buffalo. The difficult terrain necessitated cutting through or leveling hills, filling valleys and draining marshland.

Protection of the Thruway requires a complex system of culverts and drainage lines. This includes 175 miles of concrete pipe. About 600,000 ft. are used for culverts, 150,000 ft. for storm sewers and 28,000 ft. for other facilities.

Concrete pipe is an ideal choice for culverts and storm drains. Its great strength resists severe impact and sustains heavy overburdens in deep fills. Its smooth interior finish speeds drainage and provides maximum hydraulic efficiency even under the toughest service conditions.

You get more high-efficiency drainage for the money when you specify concrete pipe for storm sewers, drainage lines and culverts. Low in first cost, concrete pipe drainage systems give long years of service with little or no maintenance. These important factors add up to *low annual cost*—the true measure of pipeline economy.

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33 West Grand Avenue, Chicago 10, Illinois
A national organization to improve and extend the uses of portland cement and concrete . . . through scientific research and engineering field work

Increase vacuum-filter efficiency with PENNSALT FERRIC CHLORIDE

Whether your plant is of large or small capacity, Pennsalt Ferric Chloride can increase vacuum-filter efficiency, speed up sedimentation, meet any change in waste composition. Either with or without digestion tanks, dosing fresh sludge with $FeCl_3$ permits immediate vacuum filtration.

Pennsalt Ferric Chloride, through fast coagulation, steps up your vacuum-filter capacities. Its superior flocculating action, over the widest pH range and even in soft, highly colored waters, results in consistently drier, easier-to-handle cakes. Anhydrous and liquid forms are available in non-returnable steel drums of 150 and 450 lbs.

Write for free technical information on Ferric Chloride and other Pennsalt Chemicals for water purification and sewerage. Industrial Chemicals Division, Pennsylvania Salt Manufacturing Company, Three Penn Center Plaza, Phila. 2, Pa.

Other Pennsalt Chemicals for water and sewage treatment: Chlorine and Alum

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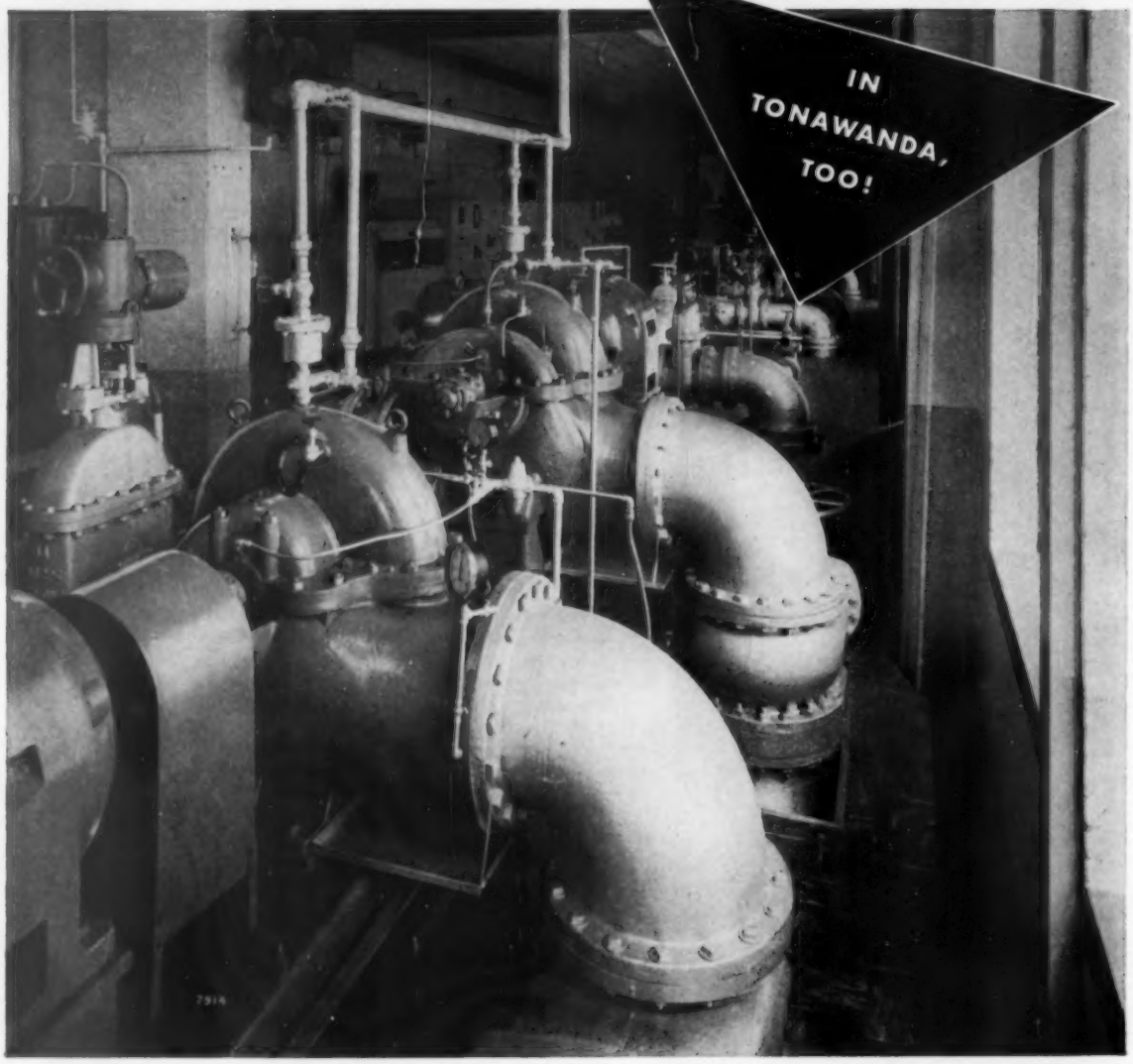
DE LAVAL pumps America's water...



Six De Laval pumps are on the job in the recently modernized Tonawanda, New York water works. These efficient pumps have a total capacity of 40 mgd, thus help meet the increased needs of this growing community.

Today 80% of all cities in the United States, with a population of 100,000 or over, use De Laval centrifugal pumps. Capacities of De Laval centrifugal water works pumps range from 100 thousand to 100 million gallons per day. *Write for your copy of new De Laval Bulletin 1004 giving data on these pumps.*

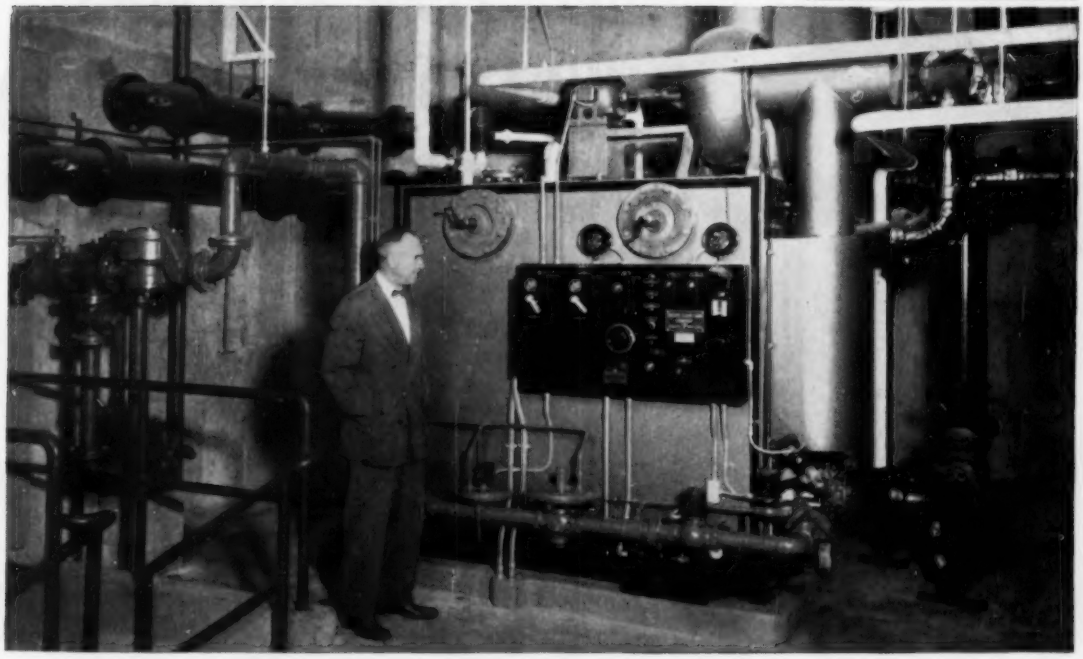
Consulting Engineers:
Metcalf & Eddy,
Boston, Massachusetts

Operating Superintendent:
Oscar B. Schulte

DE LAVAL *Centrifugal Pumps*

DE LAVAL STEAM TURBINE COMPANY
824 Nottingham Way, Trenton 2, New Jersey

DL322



Green Bay selects PFT Digester Heater for operating economy, close control

In expanding its digesting operation, Green Bay, Wisconsin once again chose PFT equipment for modern *controlled* digestion. In 1936, PFT had supplied the primary treatment plant with two Floating Covers for its 40′ digesters.

Key feature of the newly expanded plant is the PFT Heater & Heat Exchanger (750,000 B.t.u. per hr.). Located in the adjacent Control Chamber with all parts accessible, this compact unit heats sludge *externally* with no piping or equipment required inside the digesters.

PFT Spirally Guided Gas Holder installed in Green Bay's new 85′ digester. Unit has a gas storage of 28,000 cu. ft.; can be held under operating pressure of 6″ of water col.

Temperature of the sludge is maintained at optimum range by recirculating raw sludge or digestion tank contents (or a mixture of both) through the unit.

By heating sludge *outside* the digester, the unit eliminates many maintenance problems. Unlike the system in which coils are located in the digestion tank, the PFT Heater can be cleaned without interrupting the digester operation. All parts of the unit are readily accessible—return bends and sludge tubes are held in place by gasketed joints so that cleaning and adjustments require less time and effort.

The PFT Heater provides operational economy by utilizing all sludge gas produced in the digester. Fired by gas *or* oil, the unit is switched to oil only when the gas supply is low, thereby cutting digester fuel costs substantially.

Additional PFT equipment recently installed at Green Bay includes a *Spirally Guided Gas Holder* (see illustration) and a complete Gas Safety System for maximum protection against fires and explosions.

Design of plant by / *Jerry Donohue Engineering Company Sheboygan, Wis.*

waste treatment equipment
exclusively since 1893

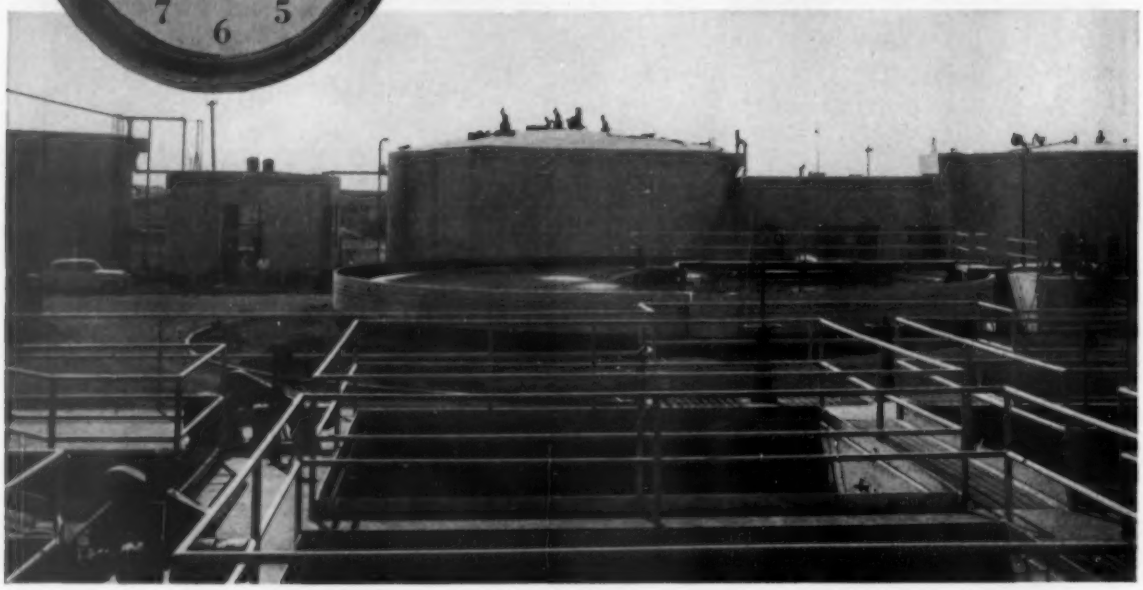
P.F.T.

PACIFIC FLUSH TANK CO.
4241 Ravenswood Avenue
Chicago 13, Illinois

PORT CHESTER, N. Y. • SAN MATEO, CALIF. • CHARLOTTE, N. C. • JACKSONVILLE • DENVER

SLUDGE PUMP STOPPAGES ELIMINATED AT SAN LEANDRO

by WEMCO the sewage pump that never clogs



The installation of WEMCO Pumps at the sewage treatment plant in San Leandro, California, has completely eliminated down time on sludge transfer service. Previous down time losses amounted to 4 to 6 hours daily. These WEMCO Torque Flow Solids Pumps replaced plunger type pumps that had been having several stoppages per day.

San Leandro's sewage treatment plant has a special problem created by cannery wastes. During the last canning season, the WEMCO Pumps proved themselves by handling the increased sludge load without once clogging.

What had been a troublesome pumping job requiring extra maintenance labor and operators' standby time has now become a simple, trouble-free, almost forgotten routine.

Because the Wemco Torque-Flow Solids Pump can solve pressing and aggravating problems in your city's sewage handling and treatment, you need the full facts. Wemco's simple "never clog" principle is fully explained in available literature. Write today for your copy.

WEMCO®
WESTERN MACHINERY COMPANY

760-L Folsom Street • San Francisco 7, California
Representatives in principal cities of the United States and Canada and in major countries throughout the world.

Here's how users feel about F&P Chlorination

Mr. Marshall Houghn, Assistant Superintendent in charge of the City Water Division Plant in Columbus, Ohio is one of hundreds of satisfied users of Fischer & Porter Chlorinators. No other chlorinator has gained so many friends so fast. No other chlorinator has proven itself by delivering continuous satisfactory service, year in and year out, with the lowest maintenance costs ever recorded. Write now for information on the complete F & P line of water and sewage chlorination equipment. A postcard will do. No obligation, of course. Fischer & Porter Co. 126 Fischer Road, Hatboro, Pa.

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THOMAS J. WATSON, JR. *Portrait by Fabian Bachrach*

"IBM was one of the first companies to . . ."

"I have always been proud of the fact that IBM was one of the first companies to put into effect the Payroll Savings Plan for the purchase of United States Savings Bonds, and I am delighted to see this patriotic endeavor continuing year by year and increasing throughout our organization. Today thousands of IBM employees, through their participation in the Plan, are helping their country and providing for the future of their families and themselves." **THOMAS J. WATSON, JR.,** ***President International Business Machines Corporation***

If employee participation in *your* Payroll Savings Plan is less than 50% . . . or, if *your* employees do not now have the opportunity to build for their future through the systematic purchase of U.S. Savings Bonds . . . a letter to: Savings Bonds Division, U.S. Treasury Department, Washington, D. C., will bring prompt assistance from your State Director. He will be glad to help you put on a person-to-person canvass that will put an application blank in the hands of every employee. This is all you have to do. Your men and women will do the rest, because they will welcome the opportunity to build for personal and national security.

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Water & Sewage Works

Only Chapman Tilting Disc Check Valves give you

FAST TIGHT QUIET CLOSURE

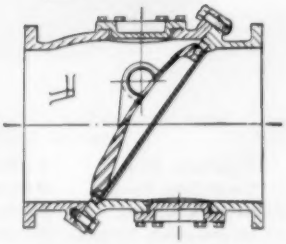
Fast, quiet operation means low cost operation for check valves. That's exactly what the Chapman Tilting Disc Check Valve is designed to do. It won't flutter or slam and damage the piping joints or the valve itself. The unique drop-tight closure action eliminates scraping and wear of the disc and seat.

Rugged construction and low wear of the Chapman Tilting Disc Check Valves mean long life under severe operating conditions. Absence of vibration plus low head loss keep maintenance of the entire piping system at a minimum.

Whether for replacement or for new piping systems, be sure to specify Chapman Tilting Disc Check Valves. They're available in iron and steel for handling fluids or gases under a wide range of pressures. For full data on the complete line, write today. Ask for Catalog 30-A.

The Chapman Valve Mfg. Co.
INDIAN ORCHARD, MASSACHUSETTS

Here's why Chapman's Tilting Disc Check Valves Keep Quiet All of Their Lives



This specially designed "airfoil" disc balances perfectly in open position. The fluid holds the disc tightly against its stops without flutter. The body of the valve is larger around the disc, so the net valve area is at least as much as the pipe area to assure low flow resistance.

When the flow is reversed, pressure against the upper part of the disc cushions it as it closes. Then the disc drops easily and tightly to its beveled seat after the valve has swung closed. Seating is fast and quiet with minimum head loss in all but unusual piping arrangements.

COILFILTER . .

Performance-proved in plant after plant

Nothing tells the full story of equipment effectiveness like actual day-by-day, full scale operating performance. We have over six years of plant scale operating experience with coil spring non-clogging filter media, and more than 50 units now in operation on all types of sludges. This number is growing steadily larger.

Put your sludge dewatering requirements in experienced hands—contact your COILFILTER representative.

Some municipalities which have recently purchased Coilfilters:

Columbus, Ohio
Carol City, Florida
Newton, Kansas
Meadowdale Carpentersville, Illinois
Sidney, Ohio
Monroe City, Missouri
Mission Township, Kansas
Blytheville, Arkansas
Portsmouth, Ohio
Storm Lake, Iowa
Decatur, Illinois

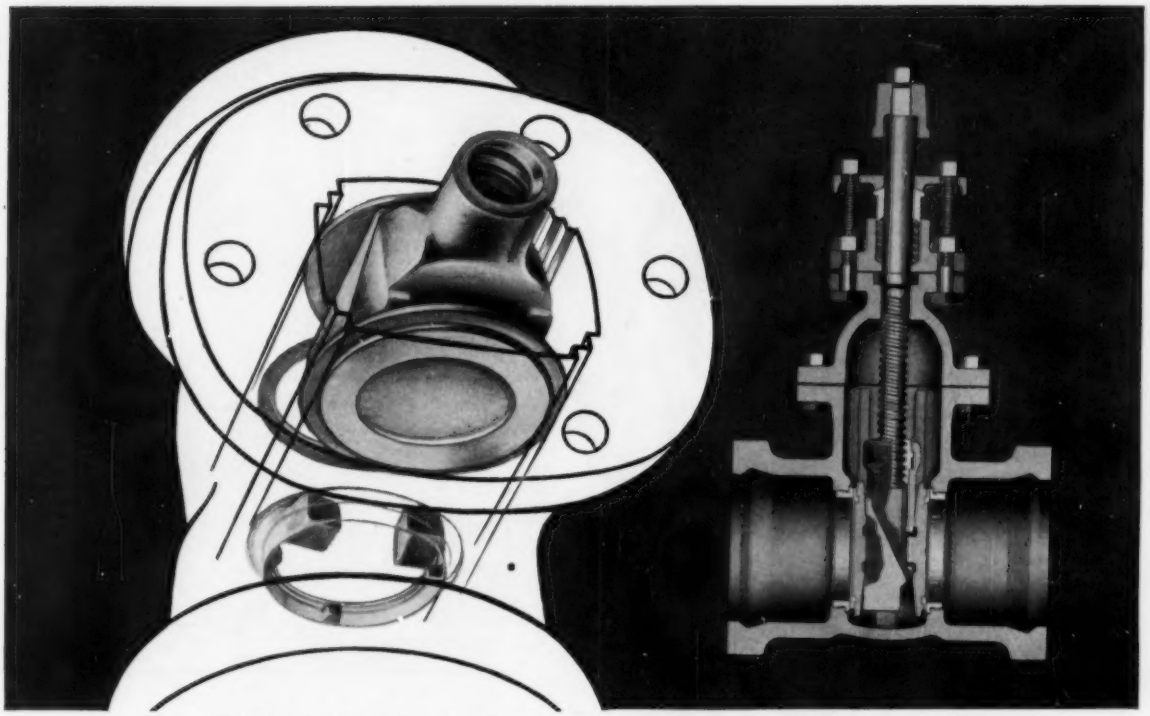
New Laboratory Facilities

Completely equipped and staffed facilities for testing and development work in connection with vacuum sludge dewatering are being opened at our plant in Peapack, N.J. You are most cordially invited to inspect this laboratory at your convenience and to make use of its facilities.

KOMLINE-SANDERSON ENGINEERING CORPORATION

Peapack, New Jersey

MANUFACTURERS OF COILFILTER SLUDGE VACUUM FILTERS



The outline drawing shows how the simple, 4-piece disc assembly is held in alignment by the guide ribs. As the disc assembly descends on the stem, the lower spreader strikes a boss in the body. Further closing movement exerts pressure on the spreaders in a wedging action, forcing the parallel discs tightly against the seats.

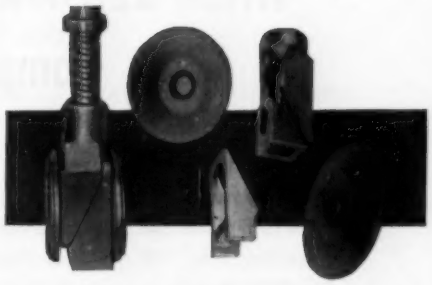
New Crane disc assembly and guide rib design improve efficiency of AWWA valves

Two design features—a simple, 4-piece disc assembly and a unique guide rib design—function together to make Crane's new AWWA double-disc gate valves a wise choice for mains and distribution lines.

The double-disc assembly, held in close alignment by the new guide rib design, cannot jam or become disengaged in service. The trunnion-mounted discs are free to rotate as they are raised or lowered, preventing concentrated wear on both discs and seats. And, the rotary motion of the discs tends to clean the seating areas.

The new Crane double-disc gate valves meet all AWWA specifications—and more! For example, the 2-piece gland and gland flange with ball type joint is well-known for preventing stem binding even though uneven pull-up may be applied on gland bolts.

These quality AWWA valves are available in sizes from 2″ to 12″. Conforming to AWWA specifications, they are bronze-trimmed and have non-rising stems. For complete specifications, contact your local Crane Representative, or write to address below.



This view of the disc assembly shows simplicity of design that makes it foolproof in action. Entire assembly is suspended freely in valve body from stem, which engages upper spreader. Discs are suspended from upper spreader by trunnion principle.

CRANE VALVES & FITTINGS

PIPE • KITCHENS • PLUMBING • HEATING

Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

WHEN RED WATER DISAPPEARED...

complaints turned to compliments

In a pleasant western community of about 40,000 population, constant complaints about red water made life miserable for the water superintendent. All that has changed, now that Calgon is on the job. In fact, he tells us "Perfect strangers stop me in the street to compliment me on the crystal clear water this community now enjoys."

Red water has stopped because Calgon* Threshold treatment stablizes iron and manganese dissolved in well water at its source. The red (or black) water problem is licked, and the capital expenditure for a costly iron removal plant avoided.

Calgon is the easy and *economical* way to keep your citizens or customers happy if your well water supply contains iron or manganese.

Calgon engineers with experience in all types of water problems in all parts of the country are at your service. A letter or phone call will put a Calgon engineer to work on your water problem.

*Calgon is the Registered Trade Mark of Calgon, Inc. for its glassy phosphate (Sodium hexametaphosphate) products.

calgon, inc.

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HAGAN BUILDING • PITTSBURGH 30, PA.

Something NEW has been added

to bring you ALL the advantages of Rex Tow-Bro...at lower cost

Now, you can have ALL the advantages of the famous Rex® Tow-Bro Sludge Remover—*at lower cost.* You get the outstanding efficiency of Tow-Bro's gentle suction action that removes light, flocculent sludge with minimum agitation, high solids concentration, fastest removal rates—at far less cost with the new Unitube Tow-Bro design.

Here's a great new CHAIN Belt development that's far more efficient than inferior scraper-type sludge collectors...assures far more effective and positive results. It's something you'll want to know about. It's the ideal sludge remover for any plant having light, "tricky" sludges such as activated sludge—round or rectangular...small, medium or large.

Get all the facts. Mail the coupon for the informative Bulletin No. 315-81. Don't delay.

CHAIN BELT COMPANY
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Send me informative Bulletin No. 315-81 describing the new Rex Unitube Tow-Bro.

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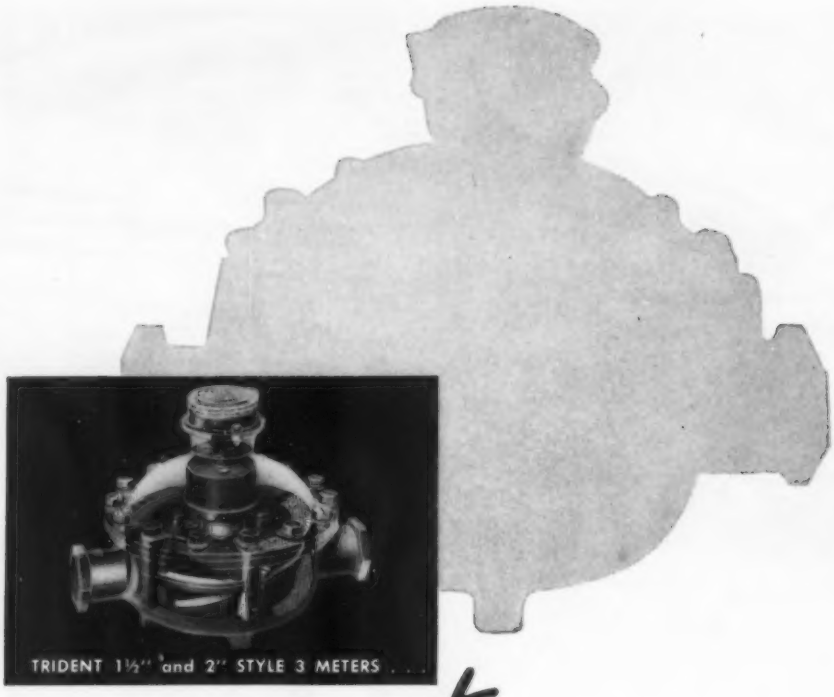

LARGE METER *Capacity* + SMALL METER *Sensitivity* = MAXIMUM *Revenue*

No proud father would argue that twins are as easy to take care of as one. That's one reason Neptune Trident Style 3 meters are recommended in place of compound meters for 1½" and 2" service lines. The Style 3 disc meter is accurate down to exceptionally low flows, and handles high flows with ease.

The simpler Style 3 meter maintains accuracy longer, and repairs (when necessary) are easier. Modern Style 3 parts fit older meters. There's no obsolescence . . . you modernize as you go. And its lower initial cost gives you a nice saving. So why use two meters when one will do the job?

Style 3 meters were the first to feature a special pressure adjustment. In high-pressure lines, the outlet of the meter is throttled to prevent overspeeding, and in low pressure installations, the outlet is opened wide to minimize loss of head.

Proof of the accuracy and efficiency of the Trident Style 3 will be found in your own testing equipment . . . in lower maintenance costs . . . and in increased revenue.

NEPTUNE METER COMPANY
19 West 50th Street • New York 20, N. Y.

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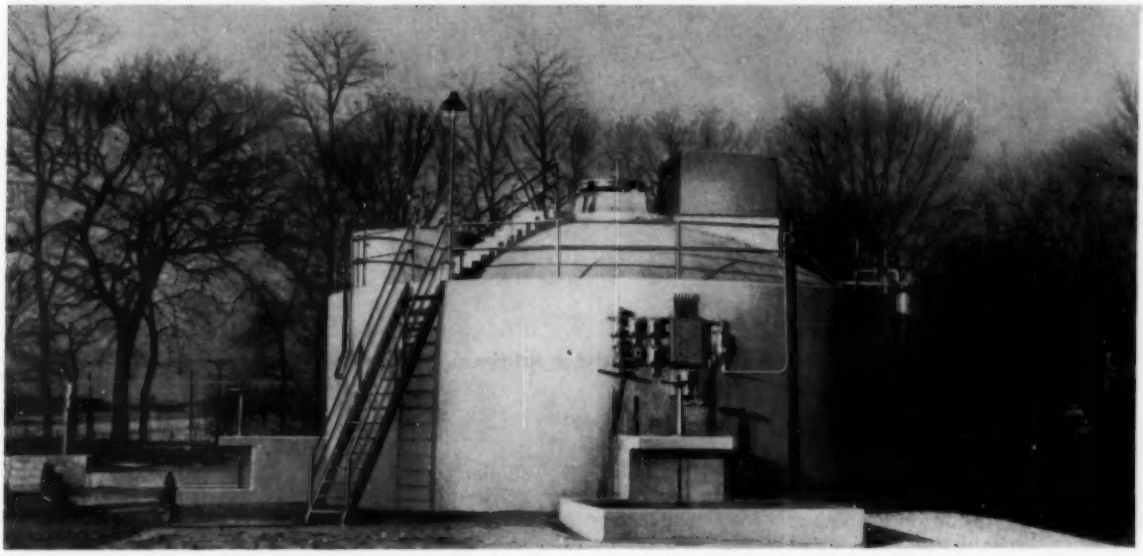
WATER & SEWAGE WORKS

VOL. 103, NO. 2 • A Scranton Gillette Publication • FEBRUARY, 1956



RELATIVELY NEW in the East is the Dorrco "Vacuator"—this 4.5-mgd unit went in at Frederick, Md.

Sewage and Industrial Wastes in 1955

A Review of the Literature, Problems, Developments and Trends of the Year

PROGRESS in the sewage and industrial wastes fields is mainly measured in economic and scientific terms. Economic progress is indicated by plants and processes which will do the job for less money, scientific progress by application of new or established scientific principles for destroying or removing pollutants by faster and better methods.

Accomplishments are the final measure of progress; in other words, how many more people and industries are served by new sewerage systems and treatment plants in the continual battle for the abatement of stream pollution. The year 1955 has seen considerable progress in this field, including economic, scientific and actual accomplishments.

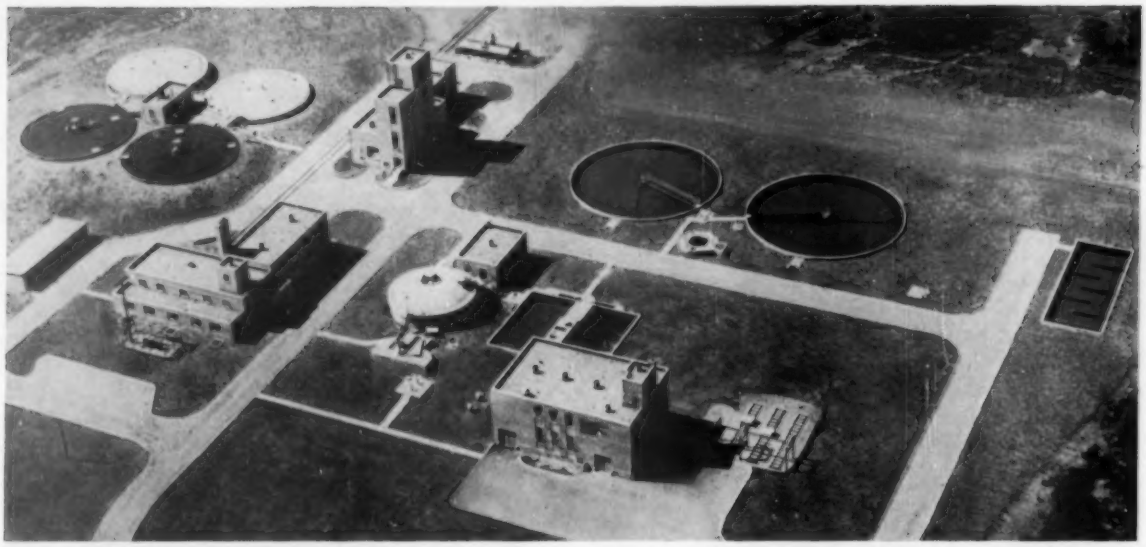
The purpose of this article is to analyze some of the more significant events reported in the literature during 1955—to feel the pulse of the pro-

by ROLF ELIASSEN and ROSS E. MCKINNEY

Dr. Eliassen is Professor and Dr. McKinney is Assistant Professor of Sanitary Engineering, Massachusetts Institute of Technology, Cambridge, Mass. **In this review they have attempted to present the material in the subject fields that is new, controversial, or in need of interpretation, with a view to provoking thought among those interested in these matters.**

Dr. Eliassen

Dr. McKinney



CHEMICAL PRECIPITATION, with sludge digestion, was adopted at Kalamazoo, Mich., because of industrial waste loadings. Plant, capacity 12 to 24 mgd, incorporates a "Vacuator"

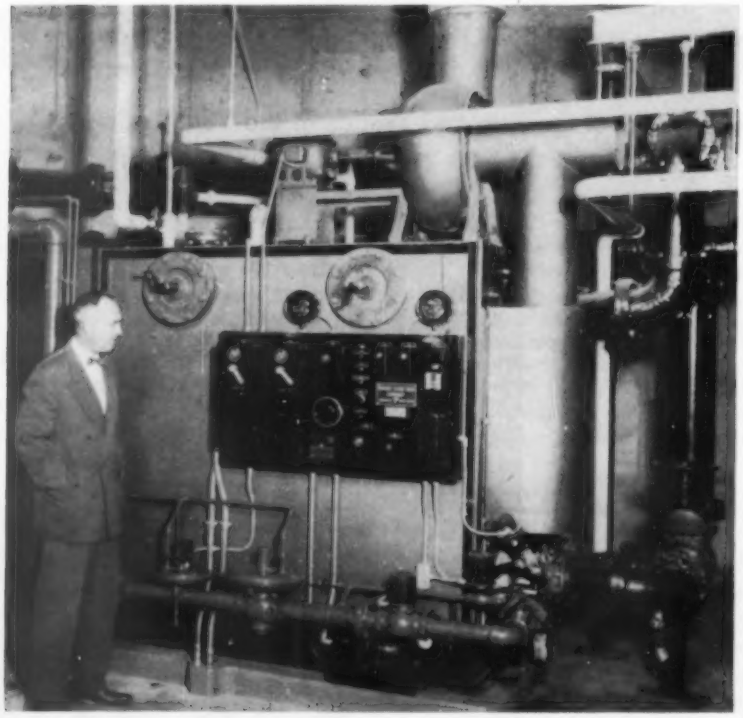
fession and observe the trends of the times.

Large new plants always capture the imagination, as they indicate one more large hurdle conquered by public health and stream pollution control authorities. One of the largest plants (47 mgd) being completed this past year is that for Miami, Fla., for the relief of gross pollution in Biscayne Bay[1]. At the same time, an island swamp is being reclaimed, thus eliminating the need for using high-valued land on the Miami side of the Bay.

The cost of the treatment plant has also been reduced because this is the first large high-rate activated sludge plant in the Southeast. No primary treatment is utilized. Aeration tanks will have 2¾-hour retention in accordance with modern design concepts.

Several features of the Miami plant are indicative of trends in sanitary engineering design and are worthy of further consideration. With varying conditions of wind and ocean currents involved in off-shore disposal it is difficult to predict the exact degree of treatment required. Provisions have been made by the consulting engineers in the layout of pumps, piping and air blowers so that the plant may be operated as a conventional high-rate activated sludge plant, as a step-aeration plant, or with the new bio-sorption flow-sheet. B.O.D. removals could be varied at will from 70 to 90 per cent. Thus, the plant may be operated in a flexible and economical manner to produce an effluent meeting the quality requirements of the Florida State Department of Health. Another feature is the reclamation of effluent by lime softening and filtration for use as process and irrigation water throughout the plant.

Waste activated sludge will be concentrated, digested, dried, and sold for fertilizer. Sludge gas engines will furnish power for compressing air.



SLUDGE HEATER by P.F.T. recently installed at the Green Bay, Wis., plant. Admiring his "new baby" is George Martin, Sup't. and Chief Engr., who is also president of the Federation of Sewage and Industrial Wastes Associations

SECONDARY TREATMENT was added at El Paso, Tex. The "Biofilters," of 220-ft diameter, are believed to be world's largest units of this type

Cost of construction is $9,000,000, or $190,000 per mgd of design capacity.

Many other new plants could be discussed, but the space allotted here is not sufficient. Some of the pertinent details of new plants are shown in the accompanying photographs and their captions.

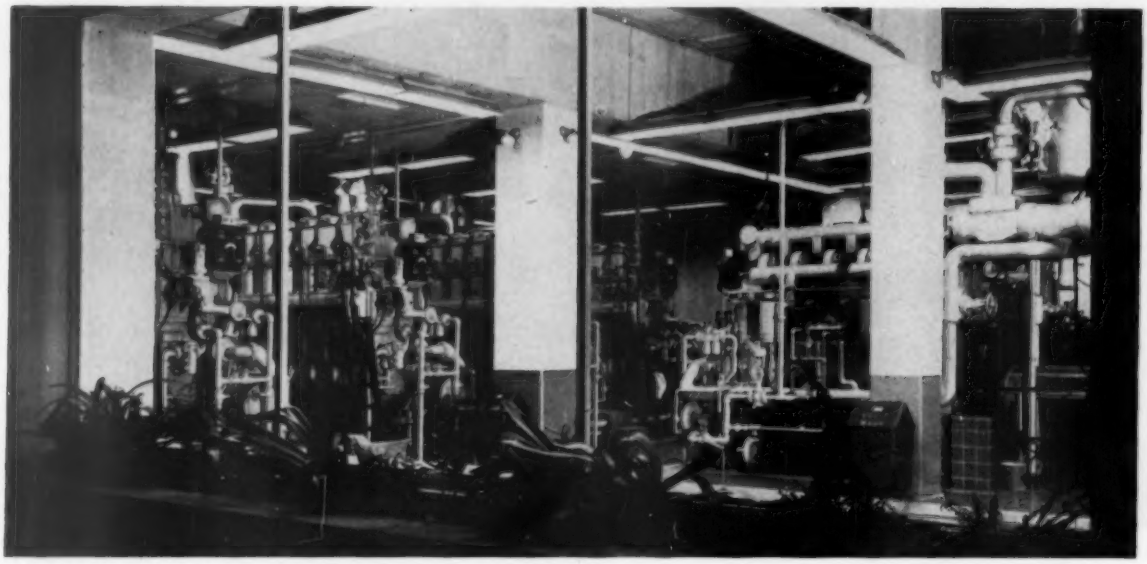
Housing, Rural and Turnpike Facilities

Sanitary engineers are being called upon to pay more attention to the design of adequate small sewage treatment plants for housing developments, rural schools and camps, and for the growing number of turnpike and express highway facilities. One of the remarkable advancements in building construction has been the use of prefabricated structures. Schools can be put up and made ready for occupancy in a week—all except the sewage plant.

To solve this problem the Dade County, Fla., School Board[2] designed a portable sewage treatment plant to be installed as rapidly as any of their 19 portable school centers could be assembled. This plant cost $17,300 and serves 400 persons at the rate of 12 gallons per capita daily. It consists of an Imhoff tank and trickling filter in steel tanks, which can be moved by trucks. As the permanent facilities are completed, the portable one will be made available for another similar installation. Utilities cannot lag in the provisions being made for our ever-shifting population and sanitary engineers must be as flexible as building constructors.

Sewage treatment plants for the Ohio Turnpike facilities[3] can be considered as typical of the manner in which sanitary engineers are meeting this problem. Experience from some of the older facilities in New Jersey, New York and Pennsylvania is being utilized to establish rational design criteria for these plants. It has been found that B.O.D. values are double those of domestic sewage. Grease de-

CONSERVATION was the keynote in this 96-inch welded steel pipeline installation from Baltimore's sewage treatment plant to the Bethlehem Steel Co. plant which is taking more of Baltimore's effluent as industrial water supply



GAS ENGINES for developing power from digester gas are rapidly becoming a "must" at sewage plants. These six Enterprise engines for driving air blowers and pumps are in the San Diego, Calif., plant

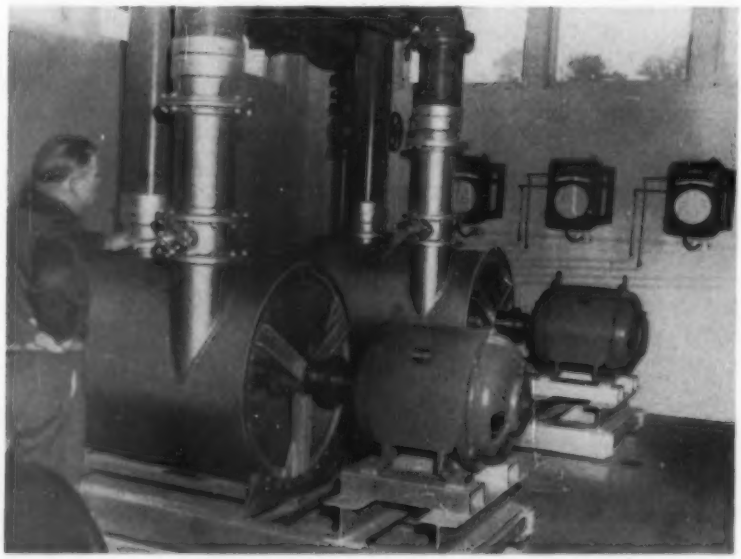
tergent contents and temperature are much higher. One of the big problems is the wide variation of flow, which ranges from virtually zero during the night hours to 350 per cent of the average during peak summer hours.

Eight sewage treatment plants, identical in design, were provided with primary settling and digestion, two trickling filters in series, final settling, and chlorination. Both filters operate a high-rate units to give two-stage biofiltration. This takes care of peak and low flows and assures a more uniform effluent. These plants constitute progress in another form: statistical evaluation of the unpredictable habits of people away from home so that required sizes of utilities may be predicted with a high degree of confidence and treatment plants can be built to protect watercourses before any pollution can occur.

Rural sanitation (sewerage systems and disposal facilities for isolated communities) is a great problem. The 1955 Federation Conference in Atlantic City and the 1955 A.S.C.E. Annual Meeting in New York programmed many papers and discussions on this subject.

Housing developers are being urged, and sometimes forced, to attack the problem communitywise rather than installing a septic tank and drainage field on each property.

Ludwig and Ludwig[4] presented a different concept of the drainage field in describing a high-rate leaching system installed in Leevining, Calif. This handles the effluent from a septic tank serving a normal population of 200 and a summer tourist group up to 800. Using eight covered leaching trenches 10 feet wide and from 100 to 120 feet long, with 18 inches of gravel under the distributing pipes, a flow of 60,000 gpd was disposed of without any maintenance at the rate of 300,000 gpad. The septic tank and leaching field cost $18,200 or $0.30 per gallon per day. Units like this are sorely needed in many small communities.

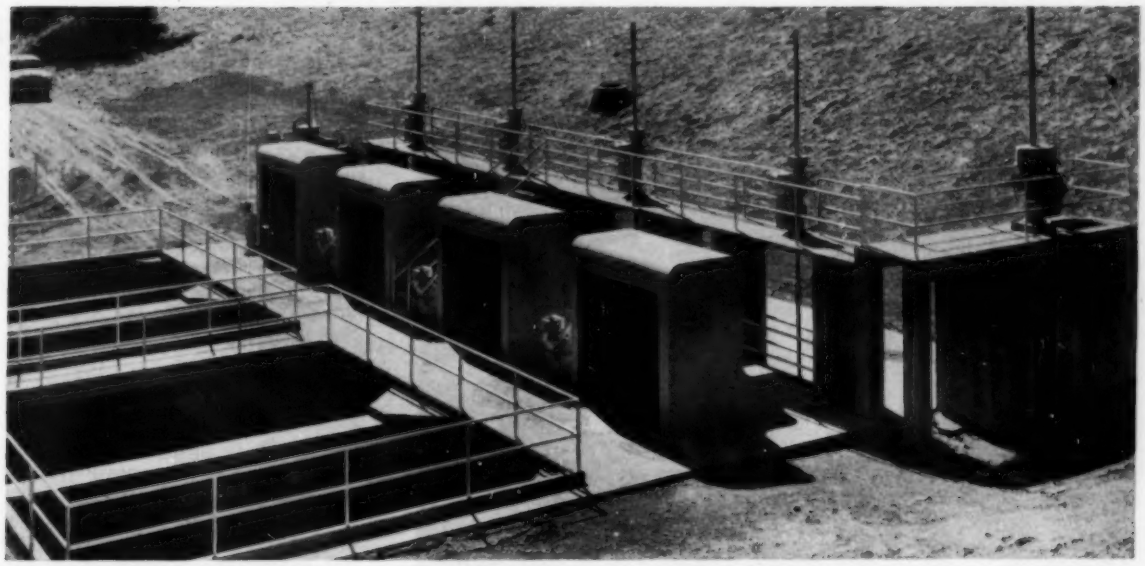


NEW TO MANY are Spencer turbine blowers, such as these in the Cambridge, Ohio, plant

Digester Design

Design criteria are changing as the newer concepts developed in laboratories and pilot plants are put into practice. One of the most notable developments has been the acceleration of sludge digestion rates, and consequent decrease in digester sizes, through the use of sludge thickening.

O'Leary reported[5] on the enlarge-



"BARMINUTORS" by Chicago Pump Co. went into the Indianapolis, Ind., plant; probably the largest "Barminutor" installation to date

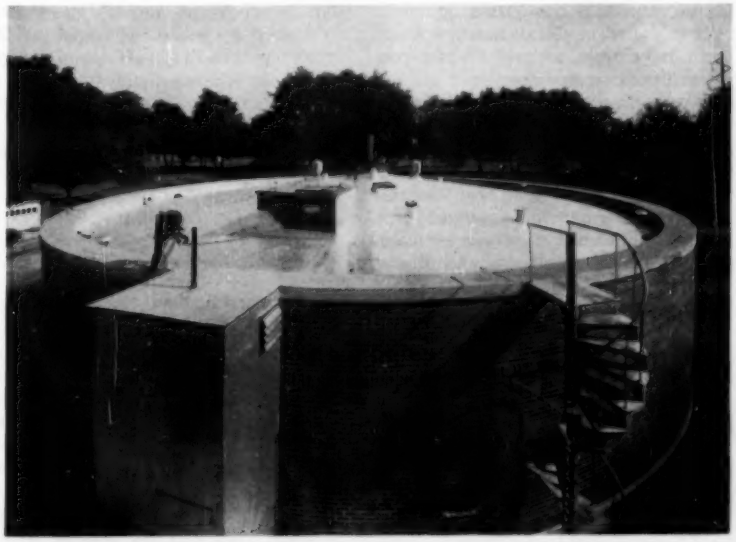
ment of the Bowery Bay plant in New York City. Capacity will be tripled, from 40 to 120 mgd. Aeration systems will provide for flexibility, with the choice of step aeration, high-rate (modified) aeration, or activated aeration as the needs of the receiving waters and economics of operation may dictate.

Of particular interest is the fact that this is the first large plant designed to use digestion of specially thickened dense sludge. Design of the new digestion system was based on actual pilot plant and full-scale operating data at the Bowery Bay plant. Using combined and thickened primary and modified aeration activated sludges, with 10.2 per cent solids, an 81-foot diameter digester was loaded at an average of 6.2 pounds of solids per cubic foot per month. Over an 11-month period this gave an average detention period of 31 days, a volatile matter destruction of 61 per cent, and 17.5 cubic feet of gas per pound of volatile matter destroyed. Using sludge from the step aeration process and thickening this with raw primary sludge to an average of 6 per cent, a loading rate of 7.3 pounds of solids per cubic foot of digester per month was possible. This gave a detention period of only 15 days and yielded a volatile matter destruction of 48 per cent over a 6-month period and 19.4 cubic feet of gas per pound of volatile matter destroyed. Compare these loading rates with those of conventional digesters.

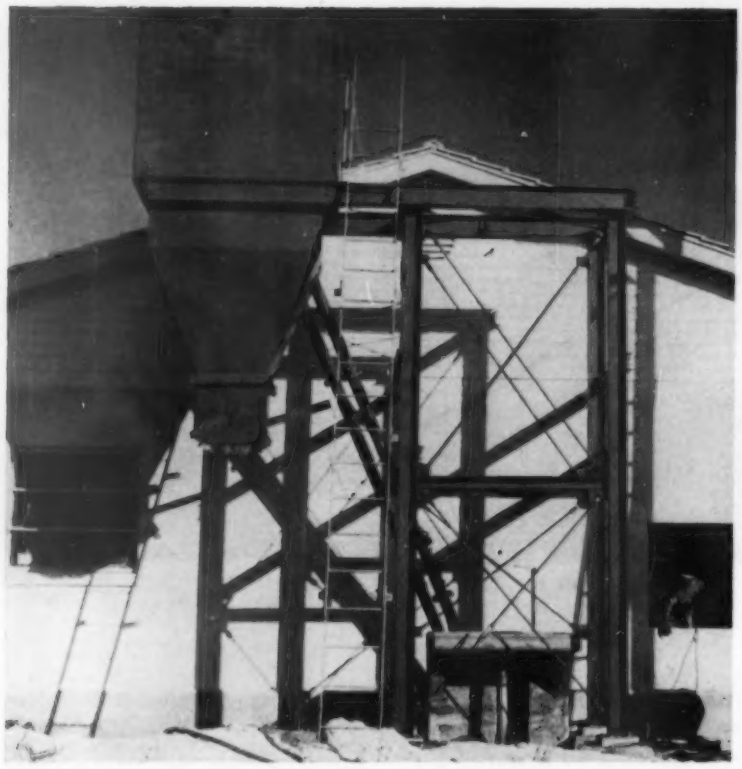
Re-Use of Sewage

Re-use of treated sewage has received further attention during 1955. Laverty[6] reported on the success of recharge wells in forcing back seawater in chloride-contaminated well waters in Southern California. As part of the tests being run by the Los Angeles Flood Control Districts, effluent is taken from the Hyperion sewage treatment plant and injected into the ground water stratum. McKee[6a] predicted that in 20 or 30 years the Southern California area will require more than twice the available supply of water from present sources. He pleaded for re-use of waste waters and estimated that an additional $20 to $35 per acre-foot would be the cost of reclamation.

Opposed to this would be the alternative of demineralizing sea water at a cost of $125 to $150 per acre-foot



LATEST DESIGN of lightweight floating digester covers by P.F.T. has box to house gas compressor for the Pearth gas recirculating scum control system



TUBULAR enclosed Hapman grit conveyor going in at Hollywood's (Fla.) new treatment plant

if no other fresh water sources were available. If the recharge wells program can be given wide adoption in areas where sea water intrusion is a problem, and there are a good number of such areas on the East and West Coasts, genuine progress in the economic area will have been achieved. What higher goal can sewage treatment have than to protect and preserve public water supplies?

Keating and Calise[7] have discussed the reclaiming of sewage for industrial re-use at two petroleum refineries in the Southwest. One plant has a capacity of 1,500 gpm for treating municipal sewage with lime and ferric sulfate. The other produces 1,200 gpm of clarified, softened and filtered refinery wastes for process use. Not only is stream pollution abatement accomplished, but precious water also is reclaimed at an operating cost of only $0.05 per 1,000 gallons. While not new, each water conservation measure of this nature is a step in the right direction and serves to make industrial management more conscious of what an intelligent wastes treatment program can accomplish.

Plant Safety

Design progress must also involve human engineering; that is, making plants easier and safer to operate. A number of sewage plant explosions have been reported from time to time. Therefore, it is encouraging to note that the new sewage treatment plant at Canton, Ohio, has a gas alarm system incorporated into the design.

Welch[8] described the system, which is arranged to draw air samples from four points between the two rows of digestion tanks. The air goes to the gas analyzer, which will sound an alarm if the methane in the sample reaches 40 per cent of its lower explosive limit. Also, a red light will indicate on a panel the exact location from which the gas sample was drawn.

Aeration and Settling

New schemes for aerating sewage and activated sludge are always of interest to designers and operators. Schulze and Foth[9] have discussed the versatile treatment plant at New Holstein, Wis. This treats domestic sewage except during the pea canning season when the organic load is increased to six or seven times above normal. The limiting factor in the treatment of the pea wastes was the air supply. The "Cavitator" unit creates and utilizes pressure differentials in the liquid to release fine bubbles of oxygen. The authors claimed that they could utilize 25 per cent of the available oxygen in the air and reported a B.O.D. reduction of 90 per cent with an air supply of only 110 cu ft per pound of B.O.D. per day. Normal air requirements with diffused air may run from 200 to 600, bearing out some of their conclusions.

However, horsepower requirements of normal activated sludge and "Cavitator" systems were not presented. This is the final criterion of aeration efficiency.

Settling tank design, based on analyses of theoretical and practical concepts, was reviewed by Fischerstrom[10]. He pointed out that efficiency of suspended solids removal was not a function of hydraulic efficiency alone, as obtained by dye tests, as some have suggested. He observed that practically all conventional settling basins can acquire the same maximum settling efficiency if they have the same overflow rate. Irregularity of flow may, under some conditions, give even better removals than a basin with undisturbed flow.

Operation

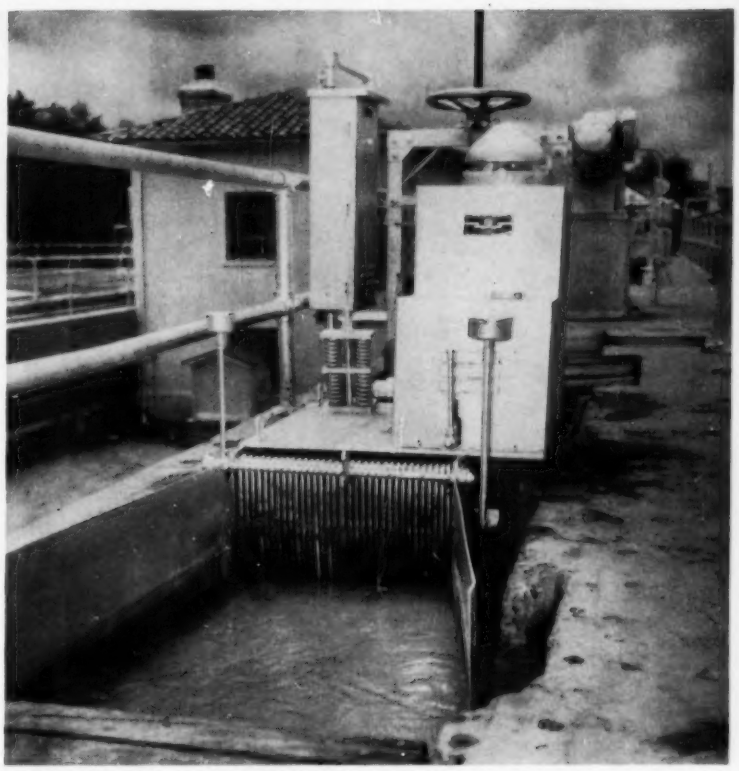
Operation of sewage treatment plants was discussed in many papers throughout the year and cannot be reviewed here. One problem—the thickening of activated sludge—always commands attention. Bradney and Bragstad[11] succeeded in concentrating waste activated sludge from 0.8 to 5 per cent solids at rates of raw feed from 3,000 to 4,000 gph. The effluent contained approximately 250 ppm suspended solids. Operating costs ran $4.37 per ton of dry solids concentrated. These tests, together with those previously reported on sludge thickening in New York City, indicate that through experimental perseverance and bright operators the difficult problems can be solved.

Small sewage treatment plants have benefited from the research program on the operation of intermittent sand filters at the University of Florida[12]. It was concluded that sand filters of 0.25 to 0.35-mm effective size, and from 18 to 30 inches deep, could handle 175,000 gpad of settled domestic sewage. Sands of 0.45-mm and 1.04-mm size can readily handle 200,000 and 400,000 gpad, respectively. B.O.D. removals were increased by more frequent loadings than twice daily. Loadings up to 300 pounds of B.O.D. per acre per day were utilized.

Some concepts of biological treatment have to be revised on the basis of work by Sawyer, Frame and Wold

at M.I.T.[13]. They showed that activated sludge can be made more flexible in its applications to problems of mixed domestic and industrial wastes. Wastes with pH ranges from 5 to 11 can be treated successfully, provided acids are not formed to depress the pH below 5. Closer attention must be paid to pH control in winter than in summer.

They also showed that periods of industrial plant shutdown up to three weeks, with no food coming to the organisms under aeration, could be tolerated without the organisms dying from starvation. Full purification capacity could be restored in two to five days after feeding of the normal organic load had started. As more disclosures are made on the fundamentals of the behavior of the activated sludge process it will gradually increase in favor and applicability to the economical treatment of domestic sewage and industrial wastes.



"ROTAGRATOR" screen and disintegrator by Infilco at the expanded El Paso, Tex., plant

Miscellaneous

Reports in the literature have continued to discuss the controversial issue of biocatalysts, including concentrated enzymes and microorganisms. A survey of state sanitary engineers[14] showed no uniformity of opinion. A very conclusive full-scale plant test was run at San Antonio, Tex., and reported by Wells and McKinney[15]. This long test showed no advantages for biocatalysts in increasing the capacity of the production of gas in well-operated digesters run in parallel. The microorganisms in these digesters made their own enzymes at a rapid enough rate to handle all of the incoming organic solids.

Although steam has been used for heating sludge for years, particularly by Rawn and the Los Angeles Sanitation Districts, a new idea along this line has been put forth by Kissinger[16]. His plant at Topeka, Kan., uses the discarded standard hot water heating coils to introduce surplus sludge gas for mixing the digester contents and steam jets to heat the sludge to the thermophilic range. Temperature measurements at four different locations indicate uniform mixing in the digester and the steam jets using the pressure of the steam alone can recirculate the waste. Results indicate that the capacity of the digester can be increased by this process.

Oxidation ponds have become of increasing interest to municipalities and industries in the warmer and drier climates where algae have their maximum effectiveness. Oswald and Gotaas[17] have made a genuine contribution to this field by formulating design criteria based on fundamental principles of oxygen production and fixing of nutrients by photosynthetic organisms such as algae.

Oxidation ponds have been tested by Steel and Gloyna[18] to determine their ability to concentrate certain kinds of radioactivity. They found that under proper conditions of operation the growth of algae and other microorganisms will virtually remove all of the radioactive cerium. Decontamination factors of 20 (95 per cent removal) have been obtained in the laboratory as mixed fission products. For aged mixed fission products each five days of operation gives an additional decontamination factor of 1.3. This can be increased by periodic removal of a fraction of the algae.

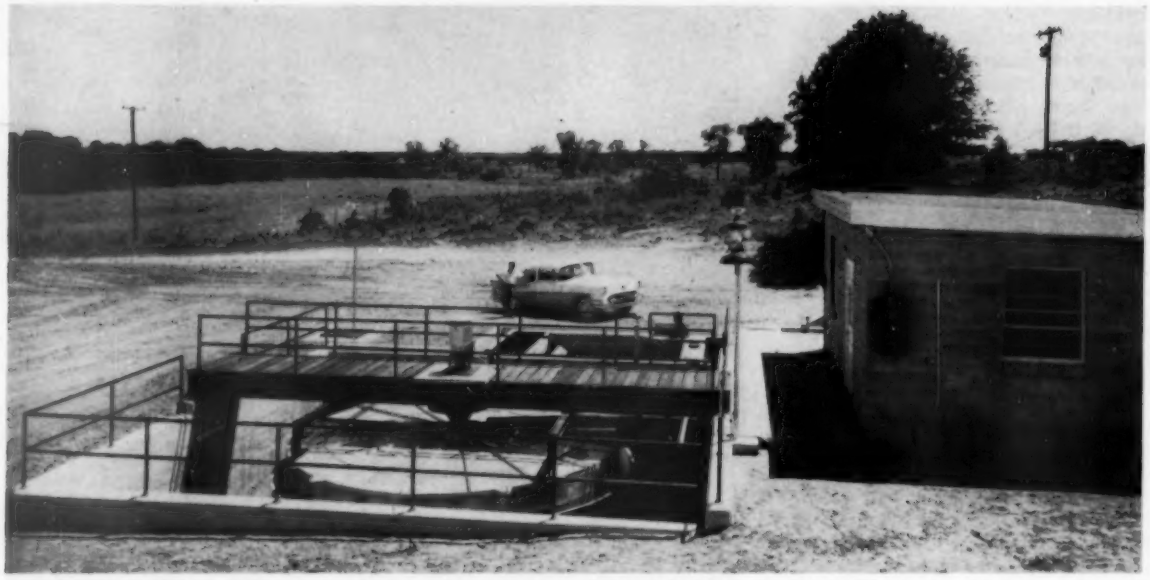
Another article[19] on radioactivity dealt with the opposite side of the picture; not the use of waste treatment processes to remove radioactivity, but the use of radioactivity in the form of fission products to accomplish waste treatment. Experiments by the U. S. Army Engineers demonstrated that sewage can be sterilized by gamma radiation without making the sewage radioactive.

The same article describes work by Selke[19] at Columbia University which showed that pulp wastes subjected to infinite doses of radiation would decompose to inorganic matter, with all elements oxidized to their highest oxidation states, and also to organic end-products including gases and charred residue.

Two-stage operation of activated sludge plants has been propounded in two recent articles. Imhoff[20] uses two aeration tanks in series, with a settling tank following each aerator. Experience in Germany has shown that primary settling can be eliminated in some cases. Imhoff claims that this two-stage system utilizes the full cleaning power of excess sludge and eliminates the large digestion volume required for the excess sludge as organic matter is burned up by oxidation.

"The Final Step in Sewage Treatment" is what Imhoff titled his article[21] pleading for the removal of nitrates from sewage plant effluents.

Curry and Wilson[22] are studying the removal of phosphates by chemical treatment to reduce algae content of Connecticut rivers and lakes. Efficient sewage treatment plants are removing organic substances but discharging inorganic nitrates and phosphates in ever increasing quantities. The problem of algae control de-



AERATOR-CLARIFIER combination activated sludge unit by Chicago Pump Co. at Dungee Park, California

mands ever-increasing attention, and may well constitute a third stage in treatment as Imhoff has suggested.

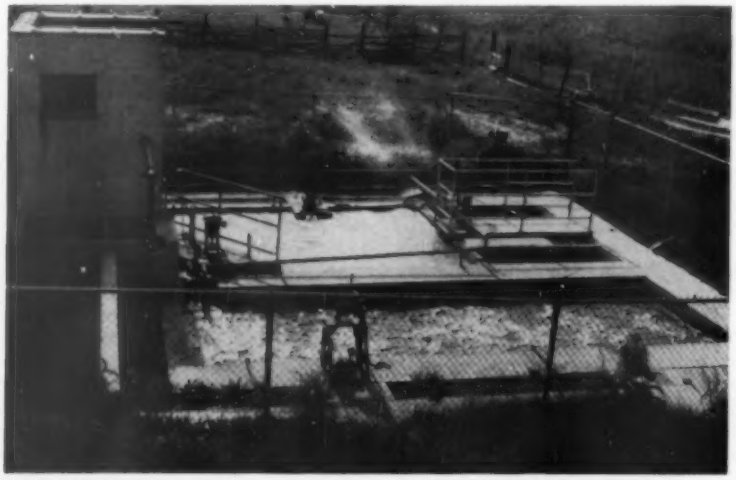
Industrial Wastes

1955 was a year of increased activity in industrial waste treatment and might well be called a year of unusual developments. Although many conventional treatment processes were applied to cannery, pickling, metal plating, textile and chemical wastes with considerable success, there were unusual modifications of conventional treatment systems. Many of these new ideas were still in the research and development stage, but there was much that could be learned from them. It has been impossible to review every industrial waste report issued during the year. But an effort has been made to cover the unusual aspects of industrial waste treatment so as to be of value in other industrial waste problems and their evaluations.

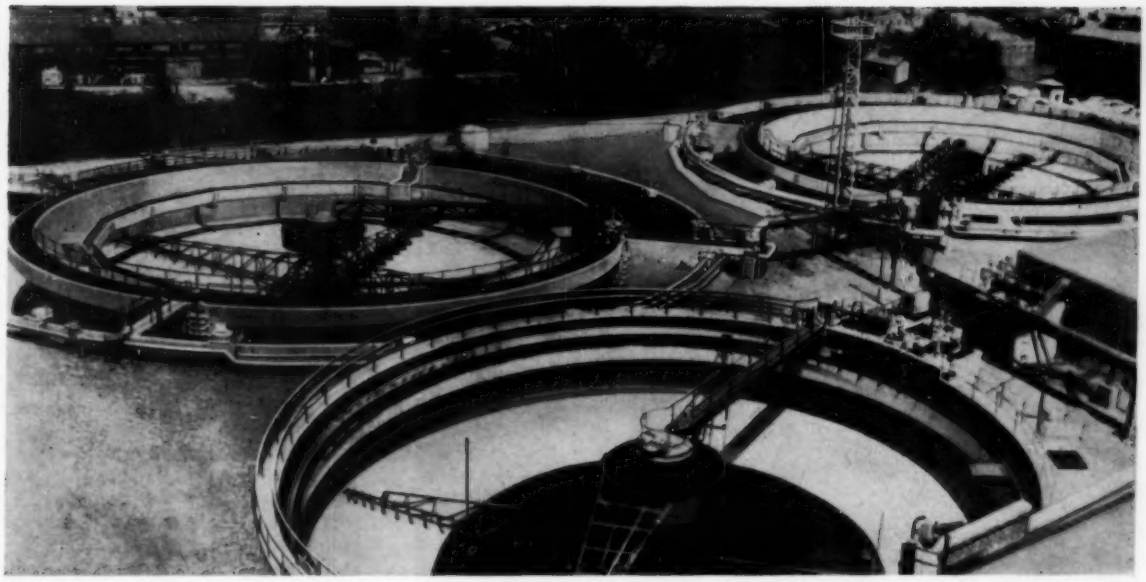
Phenol

Phenol is still one of the common pollutants in petroleum and coke wastes causing problems. Two methods for handling phenolic wastes of interest were biological and mechanical. The biological system[23] consisted of an A.P.I. separator for the removal of the free oil, an activated sludge aeration tank and a final separator for the sludge removal. The treatment plant of Sun Oil Co., Ltd., at Sarnia, Ont., handles 250 gpm of waste waters containing up to 200 ppm phenol with over 95 per cent removal. The data showed that the plant was loaded at the rate of 5 pounds phenol per 1,000 cubic feet of aeration tank volume per day. Air was supplied through 40 Penberthy eductors at a rate of 0.1 cubic foot per minute per square foot of aeration surface. Approximately 60 hp was required for daily operations.

Because of its toxic properties phenol has not been subject to biological treatment to the same extent as have other organic compounds. Yet, it is far less toxic to the microorganisms in activated sludge than formaldehyde, which has been treated at higher loadings than those indicated for this plant. One of the characteristics of a phenol adapted activated sludge is the rapid rate of metabolism. Failure to feed the microorganisms sufficient phenol actually reduces their capacity for assimilating phenol. Considering the phenol loading on this plant, there is little doubt that it is considerably underloaded from a phenolic standpoint. Actually, the sulfides in the waste will be more important in the plant operation than



MILK WASTE treatment plant by Chicago Pump Co., serving Cherry Grove Dairy at Toledo, Ohio, involves a successful modified activated sludge process



PROGRESS in industrial waste treatment is denoted in this complete plant of the West Virginia Pulp and Paper Co. at Covington, Va. It represents intensive study and the result of pilot plant operation by a forward-looking company. A modified activated sludge process is being employed

will phenol. Additional experience will show to what extent the treatment plant can be loaded and what component of the wastes is actually the limiting factor.

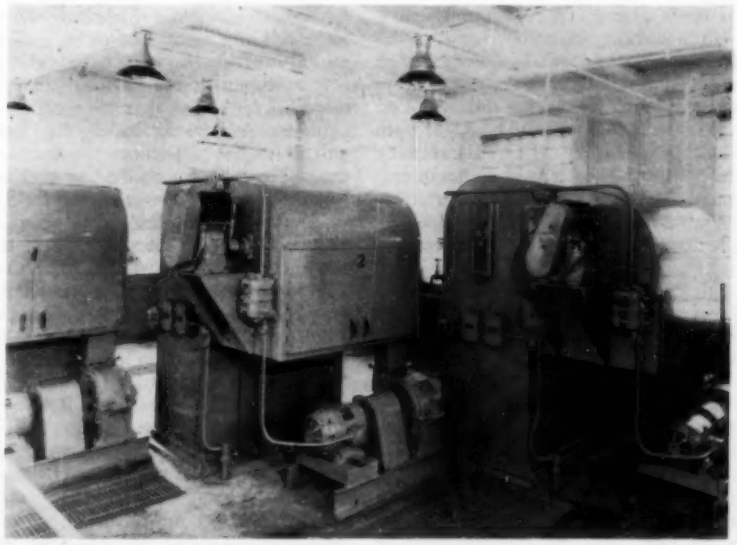
The removal of phenol from ammoniacal liquors produced by coke oven operations employs solvent extraction in which water is insoluble and phenol is completely soluble. The major problem in this system of phenol removal is the contact between the ammoniacal liquors and the solvent. This has largely been accomplished by tall packed towers. Because of the difference in specific gravity between the solvent and water, it was proposed to use centrifuges[24] to bring the two liquids into intimate contact and to separate them again. A 36-inch centrifuge operated over a 6-month period on ammoniacal liquors containing up to 2,000 ppm phenol produced an effluent containing 5 ppm or less phenol. The centrifuge is a countercurrent extractor with the heavier water being introduced at the center and the lighter solvent being introduced at the outer edge. Centrifugal action forces the heavier liquid to the outside and the lighter solvent is displaced to the center. A production-size installation handling 20,000 gph would require a 20-hp drive for starting, but only 7 to 8 hp for continued operation.

The centrifuge has a definite potentiality for strong phenolic wastes. It employs the principle of countercurrent extraction, which is far more efficient than packed tower extraction. Space requirements are also more favorable for centrifuges. There may be a place for combined use of centrifuges and activated sludge, with the centrifuge removing the major portion of phenol and the biological system finishing the treatment.

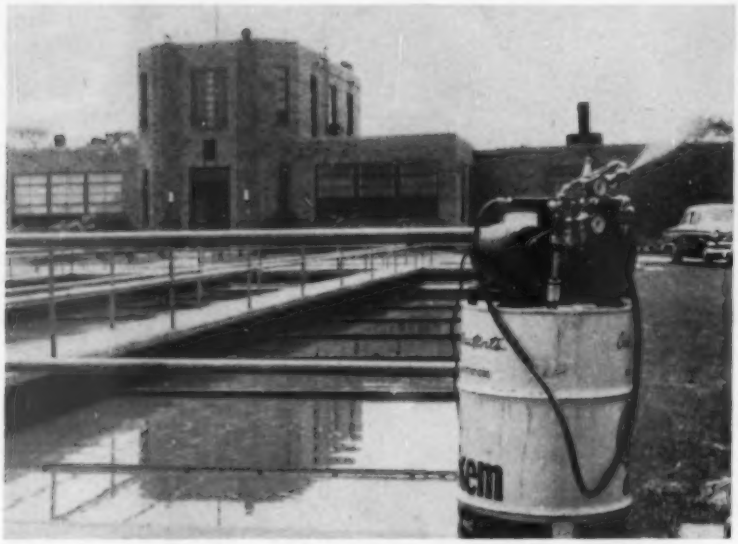
Glass Fiber

An interesting approach to the waste treatment problem of Owens-Corning-Fiberglass Corporation plant at Anderson, S. C., was discussed by George A. Rhame[25]. The waste treatment plant was designed and built without the benefit of a pilot plant or any previous experience in treating this type of wastes. The wastes were made up from the sanitary sewage of 600 people, starch, borax, formaldehyde and methacrylate chromic chloride in an isopropane-acetone emulsion.

The wastes were divided into two separate systems, one for the wastes containing chromium, and one for the



NEW BAR SCREENS of the back-cleaning type by Walker Process Co. installed at the Grand Rapids, Mich., plant



AIRKEM'S system of odor destruction or dissipation is reported as very effective

remaining wastes. The chromium wastes were treated with ferrous chloride and lime to precipitate the starch and the chromium. The sludge was sent to sand beds for dewatering. The other wastes were treated chemically with alum and lime before going to an aeration tank. This sludge was digested and dried on sand beds.

Once the plant was put into operation the chromium waste treatment unit failed to give adequate treatment because of a large concentration of soluble starch, which was not removed by chemical treatment. This waste was then mixed with the other wastes, giving a single waste to be treated.

The final treatment plant consisted of flash mixing, flocculation, primary sedimentation, aeration, final sedimentation, slow sand filters, sludge digestion, and sand drying beds. The wastes had an average analyses of 1,435 ppm 5-day B.O.D., 2,580 ppm C.O.D., pH 6.6, M.O. alkalinity 26 ppm, 6.5 ppm trivalent chromium, and 9.3 ppm Kjeldahl nitrogen. Approximately 100,000 gallons of waste are produced daily. The operating results of this plant are very good, with 876 ppm average 5-day B.O.D. from the primary sedimentation units and 15.4 ppm 5-day B.O.D. in the final effluent.

For the most part, the plant has operated satisfactorily but there have been upsets, due in part to shock loads and in part to poor operation. Once again it is the same story that is repeated so often in municipal operations, a willingness to build a treatment plant but an unwillingness to pay for skilled operation.

There were certain problems connected with this waste that can be of value to sanitary engineers, both from a design and operation standpoint. The waste was basically a carbohydrate waste and was deficient in two essential nutrients, nitrogen and phosphorus. The sanitary sewage was the chief source of both of these essential nutrients, but there was still a deficiency. In part, this deficiency was overcome with a long period of aeration (62 hours, based on raw waste flow) and by recirculation of digester supernatant. Complete satisfaction of the nutritional deficiency could have resulted in a smaller aeration tank and a lower capital investment.

A second problem is that of buffer. The wastes contain little buffer, as indicated by the low alkalinity. The addition of lime as part of the chemical treatment aided buffering in the aeration tank, but this may create a problem. Additional loading could result in acid conditions in the aeration tank. The high starch loading and the low alkalinity have already caused acid problems in the digester. The nature of this waste will require the continuous addition of lime to control pH in the digester and should have been part of the original design. Starch and other carbohydrates do not produce buffering substances, but do produce large quantities of acids which must be neutralized by an outside source if digester operation is to be maintained properly. Once again the capital cost of the treatment plant could have been reduced with proper operation of the digester.

A third point of reduction in capital cost of this treatment plant could have come in the secondary sedimentation tanks. Three hours of sedimentation for activated sludge is too long; one hour is sufficient and 30 minutes is desirable if the sludge shows any degree of activity.

Packinghouse Wastes

The anaerobic digestion of packinghouse wastes has been investigated over the past four years with considerable interest. Schroepfer et al[26] issued a rather complete report on their pilot plant studies to date. The pilot plant consisted of a holding tank, a digester, and evacuation tank, a separation tank and a trickling filter. The digester is heated by external heat exchangers and has continuous mixing of the contents. An evacuation tank is of the cascade type, with a vacuum applied to remove the dissolved gases from the sludge before separation of the sludge from the liquid.

The sludge is separated from the liquid by normal sedimentation, with continuous sludge removal and recirculation to the digester. The low specific gravity of the sludge prevented good settling and required large recirculation pumps to return all of the sludge. Fly ash was used as a weighting agent to aid the settling of the sludge in the separator. The results have shown 95 per cent B.O.D. reduction with loadings up to 0.2 pounds B.O.D. per cubic foot per day. An 18-in. vacuum was found to be the optimum economic vacuum to be maintained in the evacuation tank. As in all biological processes, mixing was found to be essential for maximum stabilization. The weir overflow rate was found to be quite critical and only 600 to 850 gallons per lineal foot were allowed. Solids concentrations in the system were optimum at 10,000 ppm volatile solids and 13,000 ppm total suspended solids. Sludge age, as defined by Gould, indicated an age of 10 to 17 days. A detention period of from 12 to 15 hours based on raw waste flow was sufficient to produce 95 per cent B.O.D. reduction. A comparison of anaerobic treatment with activated sludge and trickling filters show the superiority of the anaerobic system.

The results of this study show considerable promise for the treatment of packinghouse wastes. The principles of treatment may well find application to other strong industrial wastes. One of the major reasons for the success of this process is the buffering capacity of the wastes. The large quantities of ammonia liberated in the degradation of the proteins helps hold the pH at the proper level for rapid metabolism.

Unfortunately, the comparison of

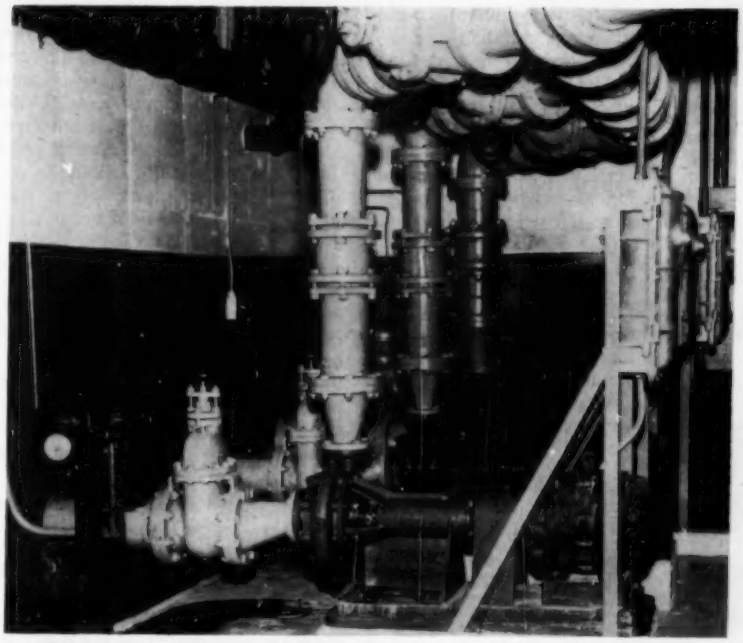
loadings and efficiencies of this anaerobic system with activated sludge is not a fair comparison. The activated sludge data used were for conventional domestic activated sludge systems and military installations and not for industrial waste systems. Data are available which show loadings and efficiencies for industrial waste activated sludge systems as high as for this anareobic unit. Therefore, the question arises as to whether or not activated sludge might not be more economical for the same degree of treatment.

Citrus Wastes

Florida still has a problem in the disposal of citrus wastes. Dougherty et al[27] studied activated sludge as a method of handling these wastes. The pilot plant used in this study consisted of a raw waste supply tank, three aeration tanks in series, a settling tank and an effluent tank. Sludge was recycled from the settling tank to the first aeration tank at the rate of two to three volumes per volume of raw wastes. Results showed that satisfactory treatment (95 per cent efficiency) resulted with B.O.D. loadings between 163 and 260 pounds of B.O.D. per 1,000 cubic feet of aeration volume per day. The plant was operated using volume of solids after 5-min. centrifuging as an index of solids to be carried in the aeration tank. Suspended solids were maintained at 16 per cent by volume in the system. It was also found that no nitrogen and phosphorus had to be added to the wastes for satisfactory treatment. Examination of the dried sludge showed 2.0 micrograms of vitamin B_{12}, as well as other B vitamins. The potential use of sludge as animal feed additive to defray part of the expense of treatment was mentioned.

Most of the B.O.D. in citrus wastes is soluble and more amenable for activated sludge than any other type of biological treatment. Citric acid and sugar are rapidly oxidized and converted to protoplasm. Unfortunately, a complete analysis of the raw wastes was not given. The exact degree of deficiency of nitrogen and phosphorus were not known. Both nitrogen and phosphorus were added to the system initially, but were cut down as time proceeded. The final runs were made without supplemental nitrogen and phosphorus. The authors concluded that none were required. Unfortunately, no effort was made to build up a sludge on the wastes directly.

The nutritional requirements are based on the actual quantity of protoplasm formed. If no protoplasm is formed there is no need for additional nitrogen and phosphorus. A measure of protoplasm formed lies in the sludge wasted each day. Failure to utilize standard measurements for solids contained in the system definitely hinders the value of this work.



COLOR SCHEME painting of sewage plant pipelines is gaining wider use for identification of lines as well as protection

Pea-Blancher Wastes

Wastes from the blanching process in pea canning constitute 7 per cent of the process waste flow and exert 30,000 ppm B.O.D., 69 per cent of the total B.O.D. Olivier and Dunstan[28] undertook studies on these wastes in a two-stage anaerobic digestion pilot plant. Initial efforts to start the system met with failure and two pilot plants were constructed. One of the new pilot plants was fed two volumes of pea-blancher wastes and one volume digested sewage sludge. The other pilot plant was fed two volumes of waste to one volume of effluent from the secondary digester.

The digesters were loaded at the rate of 130 lb volatile solids per 1,000 cubic feet of digester capacity per day with a 10-day retention period. Continuous mixing insured optimum operation. Over 90 per cent B.O.D. reduction was obtained in both systems. Dropping the digestion time to 9 days increased the loading to 210 lb volatile solids, but did not reduce the efficiency of operation. While the addition of one-third by volume digested sludge would not be practical, it did show the need for increased initial seed to get the system started and a source of buffer to hold the pH of this carbohydrate waste at the proper level. Actually, the practical method of handling this was shown in the recirculation of digester effluent. The bicarbonate buffer that normally would have been lost in the effluent was saved through recirculation, as were some of the desired bacteria. This was another good example of the application of biological principles to a strong organic waste.

Anodizing Wastes

Ion exchange for waste treatment came into view in a discussion of the treatment of chromic acid wastes from the anodizing of aluminum aircraft parts[29]. The rinse waters and the spent bath can be treated either chemically or by ion exchange.

The chemical method consisted of reducing the hexavalent chromium to the trivalent state and then neutralizing the wastes to precipitate the chromium. The ion exchange system permitted removal of the excess aluminum ions in a cation exchanger. Purified chromic acid is then returned to the system. The cation exchanger is controlled by conductivity measurements and is regenerated with 10 per cent sulfuric acid.

The rinse waters are treated separately by adding sodium hydroxide to form sodium chromate and then passing it through an anion exchanger where pure chromic acid is formed

and returned to the anodizing tank. A cation exchanger removes the sodium ions and permits recovery of rinse water. The use of ion exchange saved $18,762 per year in chromic acid and rinse water, while costing $5,550 in operating expenses. The chemical method would lose all of the chromic acid and the rinse water, as well as requiring an additional $9,100 per year for chemicals. Both systems had the same capital costs, $35,000, so that by the use of ion exchange $22,000 per year was saved and the chromic acid anodizing wastes were eliminated. This example definitely points to the potentialities of ion exchange in treating certain types of plating and metal cleaning wastes.

Research

Research is the heart and soul of industrial waste disposal. As has already been illustrated, much of the work during the past year has been pilot plant research preparing for full-scale design. There were other research studies on a smaller scale which have much to offer to those interested in industrial waste treatment concepts and design.

The Research Committee of the American Society of Civil Engineers[30] reported on the work of Amberg dealing with the disposal of nutritionally deficient sulfite waste liquor to streams. The importance of nitrogen and phosphorus was shown in B.O.D. tests run on river water with and without nutrients. The rate of deoxygenation, k_1, was lower without the proper nutrients. Unless an external source of nutrients were added to the river, the rate of stabilization of the wastes would be prolonged and would not create as great an oxygen sag as would occur if nutrients were available.

Conversion of sulfite pulping operations from a calcium base to an ammonium base would supply ample nitrogen and would accelerate the rate of deoxygenation. This study tends to illustrate the complexity of stream pollution problems and the need for a thorough understanding of microbiology and biochemistry in interpreting stream pollution data.

The report of Heukelekian and Rand[31] showed the variability of B.O.D. data obtained by various investigators on pure organic compounds. This variability has been a handicap to industry in the proper determination of B.O.D. of their wastes. For the most part, all but the simple organic compounds require an acclimated seed if proper B.O.D. is to be exerted.

This was recognized by Mills and Stack[32], who set forth a suggested acclimation procedure for seed to be used in B.O.D. work. The use of an acclimated seed is essential if B.O.D. data are to have real significance. While an unacclimated seed may permit an industry to think it has less of a problem than it does, it will not be an asset when a treament plant is built and in operation.

Weston and Eckenfelder[33] attempted to translate into mathematics the fundamental mechanisms of industrial waste stabilization by biological processes. The basic concept of the conversion of organic matter to cellular protoplasm as a definite thermodynamic reaction is the key to proper understanding of the design and operation of biological waste treatment facilities. Unfortunately, the mathematics are so complex that most of the value of this work is lost to all but the most avid researcher.

The keynote for 1955 in industrial wastes might well have been "unconventionality," for the trend was away from the conventional treatment processes. This trend was the result of economic pressure by industry for more economical treatment. The sanitary engineer was faced with centrifuges, ion exchange, and high-rate biological treatment systems, both aerobic and anaerobic. There was no set solution to any problem. Each had to be investigated and solved on its own merits, with economics controlling the entire process.

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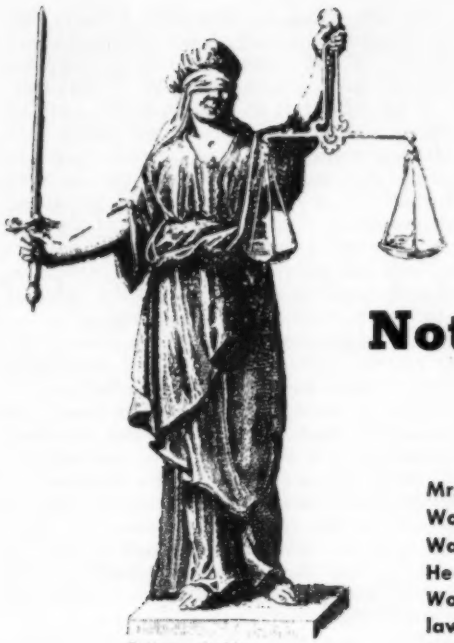

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Notes on Water Works Law

by JOHN H. MURDOCH, JR.

Mr. Murdoch is Vice-President of American Water Works Co., Inc., and Chief Counsel of American Water Works Service Co., Inc., Philadelphia, Pa. He has prepared exclusively for *Water & Sewage Works* this series of articles discussing water works law as it applies to source of supply, water quality, and water distribution.

Seventh Installment—Legal Meaning of "Water Rights"

THE subject covered in this installment is presented out of its proper place. Its preparation and publication are due to the receipt of inquiries about the true legal meaning of the term, "water rights." These inquiries revealed to the author the fact that in the earlier installments the phrase was seldom, if ever, used although it is frequently used in conversations among water works men and in legal publications.

In retrospect it is realized that some general definition of "water rights" should have been included in the first installment, perhaps, as a part of the "Author's Preface" published in *Water & Sewage Works*, November 1954, page 481. In partial justification for the omission it can be pointed out that these notes are on Water Works Law and are not intended to be notes on the Law of Waters or Water Rights. It might be said that these notes cover the law of water rights only as that law has an impact on water works practices.

Some idea of the wide field included in the branch of the law known as water rights can be gained from a reading of part of the preface to Farnum on "The Law of Water and Water Rights," published in 1904 by The Lawyers' Cooperative Publishing Company. The general title of the treatise is followed by a subtitle as follows: "International, National, State, Municipal and Individual Including Irrigation, Drainage, and Municipal Water Supply." The preface to Volume 1 reads in part as follows:

"The rules governing the rights in, upon, and concerning waters form one of the most important branches of the law, when viewed in the light, either of the demands which their application has made upon the courts, or of the social and economic relations which are affected by them. The courts have been called upon to apply these rules in nearly 17,000 cases. And their application forms a material part, not only of the substantive law governing real property, the relation of landlord and tenant, contract rights between subject and subject, the rights of nations, and the relation of sovereign and subject, but also the derivative law as found in the question of liability for torts, active and passive, and the abatement of nuisances. * * * In addition to full treatment of the subjects which have been ordinarily incorporated in treatises on waters and water rights, such as rights in tide waters and streams, subterranean and surface waters, and rights of appropriation, an exhaustive discussion has been attempted in these volumes of the question of municipal water supply and sewerage, the law relating to fisheries, ferries, and canals, and the rights and duties between landlord and tenant with respect to water."

Definition of "Water Rights"

The quotation shows the scope and the complexity of the material incorporated in the treatise. Yet no general definition of "water rights" has been discovered in the work by the writer of these Notes. Perhaps such a general definition could be stated in this way: *Water rights are the powers or privileges—recognized as validly existing under the applicable system of law—in, upon or*

concerning waters, as such powers or privileges held by nations, states, corporations or individuals exist in the light of the powers and privileges of opposing parties.

Thus, for illustration, a state of the United States has the power or privilege of granting to a municipality of the state the right to divert water from one of its rivers. If, however, that river flows into a second state that second state has rights in the waters of the river and if the diversion granted by the first state would not be lawful under international law because it infringed on the equitable rights of the second state, then the state granting diversion could be restrained by the United States Supreme Court. In the illustration it might be said that the diverting municipality had a valid right as against its own state under that state's law, but it would suffer because the granting state was exceeding its water rights in the stream.

Riparian rights are powers or privileges concerning waters of streams enjoyed by the owners of lands through which a stream flows or on which it borders. The law of riparian rights is then a branch of the law of water rights. The law concerning stream pollution is in part a branch of the law of riparian rights and in part a branch of the law of police power.

Municipal water supply law involves the law of water rights in its riparian rights branch, its stream pollution branch, and also the more abstract or theoretical law of the rights of the state as sovereign to control the waters of the state for the public. The various and often conflicting interests in waters having to do with fishing, navigation, and water power development involve the law of water rights in one or more of its branches but will not usually involve water works law. The law concerning public water supply in its relations with customers, or in relation to liability for damages caused by fire or for various torts, such as the furnishing of impure water or damages due to leaking mains, might possibly be said to be related to the law of water rights. If related, however, the relationship is remote.

This installment of "Notes on Water Works Law" will cover the law of water rights in its riparian, stream pollution and public diversion aspects. It will, in effect, be a review of some of the matters covered in earlier installments but without citation of authorities. In this way it is hoped that the inquiries received from water works men as to the meaning of "water rights" will be adequately answered. It will be understood that in the general definition previously formulated there are included other phases of water rights law which are entirely outside the scope of this work.

Water Rights of Riparian Owners Outside the Semi-Arid West

In this section it is proposed to offer an explanation of the powers and privileges in, upon or concerning waters of streams possessed by the owners of lands through which a stream flows or on which it borders. The lands which border on a stream or through which a stream flows are called "riparian lands" and the owners of the lands are called "riparian owners." The powers and privileges which riparian owners have concerning the waters of the streams as to which their lands are riparian are "water rights" which, in this category, are referred to as "riparian rights."

Riparian lands are lands which touch upon a stream or lake. It makes no difference in this respect where the thread of the stream may be or where the middle of the channel may be. Land which merely touches on the natural bed of the stream is riparian land, although title to that bed may be in other ownership.

Where valid title passes by deed with a description of the land conveyed containing some such language as: "Thence North 20° 30′ West 275 feet to Chartiers Creek; thence by lands now or late of W. C. McClane, South 25° West 1,250 feet to a point on the bank of said Chartiers Creek, etc.," the description would indicate that McClane owned the bed of Chartiers Creek in that section and that the land conveyed might no more than touch the creek at two points. Yet the grantee in such a deed would by virtue of ownership of the land conveyed by it become a riparian owner as to Chartiers Creek. As such his rights concerning the waters of Chartiers Creek would be as extensive as the rights of McClane, the owner of the bed of the stream.

This point is often overlooked. Let us assume that Smith, the grantee under the deed in the illustration, acquired land by that deed and through other conveyances all within the watershed of Chartiers Creek and all contiguous with the land acquired under this deed, then all of such land of Smith would be riparian land and would have—as part of the entire tract—water rights concerning Chartiers Creek, although of the entire tract only one or two points on the boundary even touched the creek. If, however, later Smith disposed of part of his tract, only that part which actually touched the creek would be riparian land with water rights with reference to the creek.

Both McClane and Smith, as owners of riparian lands, would have the right, for example, to take water from the creek for domestic use in houses on their riparian lands without distinction between them as to quantity, even though one might own more riparian land than the other. They would each be possessed of the water right to take water from the stream to water stock on their riparian lands. However, Smith could not drive his stock into the stream to water without trespassing on the lands of McClane.

Neither, as riparian owners, would have the water right to take water from the creek for use on non-riparian lands. If part of the contiguous lands of either extended beyond the limits of the watershed of Chartiers Creek, that land would not be riparian and the owner would not have the water right to use water from the creek on that land.

As was pointed out in earlier installments of these Notes, the use that each may make of the creek water must be a reasonable use. Although water may be used for watering stock on riparian lands, it is doubtful if the water right would be held to cover the watering of herds far beyond the capacity of the riparian acres to support. It is doubted that the water right would cover use for sanitation for a large institutional development on the riparian land. This is for the reason that the water rights of each riparian owner are held subject to the water rights of other riparian owners.

Stated generally, each riparian owner has the water right to have the waters of the stream to which his lands are riparian reach him undiminished in quantity and unimpaired in quality, with the qualification that the lower riparian owner's water rights are held subject to the water right of upstream riparian owners to make reasonable use of the waters of the stream on riparian lands.

No general rule can be stated for determining what uses are reasonable. Reasonableness of use must be governed by the circumstances of each case. Each owner has water rights, but each has also the duty to respect the rights of others. Uses which impair the quality of the water of a stream unreasonably are uses in excess of the riparian water rights.

If water may be used to water stock, however, then some impairment of quality must be within the water rights of riparian owners unless highly unusual precautions be taken. Certainly stock could not be allowed to pasture in a field through which the stream flowed and to drink from the stream without impairing the quality of the water. Yet, as between riparian land owners, such use is commonly accepted as a reasonable use and as a lawful exercise of a water right.

Industrial owners of riparian lands have no more and no less riparian water rights than owners of lands used for residences or farms. However, it is a fact, as was pointed out in the third installment of these Notes, that a developing community, until recently, has tended to be lenient in enforcing against industry the restraints imposed on others.

This tendency has been reversed in the last few years with the realization of the dangers involved. As a result, pure stream laws are tending to bring the police power of the states into play to put limits on uses for industry impairing water quality. These laws, in effect, supplement the riparian water rights of downstream owners.

As was pointed out previously, the owner of riparian lands does not have the water right to use the water of the stream on non-riparian lands.

One result of this principle is often overlooked. A riparian owner, or even a group of such owners, may sell to a non-riparian owner the right to divert water away from the stream for use on non-riparian lands. Since the grantor in such a transaction owned only the right to use the water reasonably on riparian lands it is obvious that the purported grant could not convey this right of diversion.

All that such a transaction could accomplish would be a waiver of damages on the part of the grantor for the loss to him involved in having the quantity of water in the stream diminished. As against other riparian owners and as against the state, the diversion would be without right and could be restrained. Thus the diverter would not have a riparian water right, but only a freedom from claim for damages on the part of his grantor for what would otherwise be an unlawful diversion of water.

Water Rights of States and Public Water Supply Agencies

Some discussion of the water rights of the states and of public water supply agencies is necessary. Water naturally flowing in streams or open lakes is not the subject of ownership. All that anyone can claim of such water is a right to use. So, in a sense, until water is taken out of its natural state and reduced to possession the only water rights that relate to it are rights concerning water, rather than rights in or to the water as distinguished from its use. Under ordinary circumstances, when we speak of water rights we are speaking about usufructuary rights, merely.

In the United States—certainly, at least, in the humid east where the common law principles of water rights are recognized—the states are the owners of the intrastate streams subject to all private riparian water rights. The states do not own the water, but it might be said that they own the streams in which the water flows no matter who owns the bed of the streams.

The riparian owners have a property right to the flow of the stream and to a reasonable use of the waters. The states, as trustees for the public, own the streams and by virtue of such ownership may control the use of the streams.

Without making compensation to riparian owners for

invasion of their water rights, a state cannot directly or through its nominees divert water out of a stream. As the states have this ownership of the streams as a trust for the public, a state could not authorize a diversion for any but public uses and could not itself take by the power of eminent domain for any but public uses.

From this it follows that a state does not have the water right to divert water from its streams for strictly private industry, or to authorize such diversion. All of its rights in the residual uses of the waters of its streams are held for the public, not for private uses.

The uses made of water by public water supply agencies are public uses. The municipalities, authorities, other governmental bodies, and privately owned public water supply agencies take water under state grant of authority for public purposes. All are under some form of public control and perform a public function.

The people of a community cannot by individual effort supply themselves with a water system adequate for modern needs and must turn to some sort of public enterprise to meet the need. Public water supply agencies are formed to perform this public function and, as such, are properly vested with the right from the state to divert water from state streams. They, then, have the water right to divert water from streams under grant from the state in the exercise of its water right to control the use of the waters in its state streams.

The public water supply agencies do not divert water by right of ownership of riparian lands. Riparian owners have a water right only to a reasonable use on riparian lands and only under almost impossible circumstances could all of the lands serviced by a public water supply agency be truly riparian.

By purchase or by exercise of the power of eminent domain the agency may have acquired freedom from claims of damages from lower riparian owners, but such freedom is not the complete equivalent of the right of diversion granted by the state.

Public agencies have much higher water rights, both as to diversion rights and rights to freedom from stream pollution, if their rights are based, ultimately, on state recognition as public agencies. However, in the eastern states at least, a grant from the state of the right to divert does not divest the riparian rights of downstream owners. The public agency can divert only subject to

their water rights or after acquiring them by some lawful means.

Subject to the vested property rights of riparian owners and to the qualification that a state owns its streams as trustee for the public, a state's water rights are absolute as to streams completely within its borders. Subject to the rights and qualifications mentioned, the state of New Jersey probably has complete legal control over the Raritan River, which has all of its sources and its entire course within the state and which reaches tidewater within the boundaries of the state. If it so wished it could authorize the cities of Newark, Perth Amboy and New Brunswick to take the entire flow of the river for a public water supply for their people. Compensation would have to be paid to owners of riparian rights adversely affected, but the state could thus allocate the waters of the river to some cities and deny them to others.

A different situation exists, however, where interstate streams are involved. Here the water rights of each state are affected by the water rights of one or more other states.

As to these rights involving more than one state, the principles applicable in the east to conflicts of interest between individual riparian owners do not apply. The Delaware River has sources in New York, New Jersey, Pennsylvania and Delaware, and its main stem is within or flows along the borders of each one. New York is taking water out of headwaters of the river and taking it into the watershed of the Hudson River for supplying part of the water needs of New York City. New Jersey wishes to divert waters from the main stem, over a divide, to help to meet water demands in industrial northeastern New Jersey. Pennsylvania and Delaware use water from the river for water supplies, mostly if not entirely within the watershed of the river. Southwestern New Jersey also wants water from the river for use within its watershed. All of these states except New York are interested in maintaining a good flow in the river for reasons of sanitation and river navigation.

With this state of facts the states involved have been before the United States Supreme Court at least twice and efforts have been and are still being made to arrange an interstate compact in some form or other to compromise the various interests. At present New York is being permitted to develop its headwater diversions to a limited extent on condition that the river flow at Trenton is maintained to at least a minimum fixed amount by releases from New York's storage.

The matter is being approached on the basis of interstate equity rather than on the basis of riparian water rights. The lower river states are not in the commanding position that lower riparian owners would occupy at common law and, on the other hand, New York is not being permitted to monopolize the New York contribution to the total flow.

Conclusion

The law of water rights is complex and only small segments of it have been treated here. As has been stated, water rights are the powers and privileges in, upon or concerning waters which are recognized in law.

Lloyd Nelson is Dead

H. Lloyd Nelson died in Birmingham, Alabama, on December 27th as the result of a heart attack. He was 52 years old.

He started with the United States Pipe and Foundry Co. in 1924, served in various capacities in the sales department and became Eastern sales manager. At the time of his death he was Director of Market Research, Promotion and Product Scheduling.

Mr. Nelson was born in Philadelphia, Pa. He was a graduate civil engineer from the University of Pennsylvania, a member of Tau Beta Pi and Sigma Xi and a registered professional engineer in Pennsylvania.

He served with the Utilities Branch of the War Production Board during World War II and again on a part time and advisory basis with the National Production Authority during the Korean emergency.

He was a member of the American Water Works Association, a former director, served at various times as secretary-treasurer of three different sections of A.W.W.A. and was recipient of the association's Fuller Award for meritorious services. He was also a member of the American Soc. of Civil Engineers, Federation of Sewage and Industrial Wastes Associations, National Society of Professional Engineers and the Civitan Club.

His life-long Boy Scout activities included Eagle Scout, Silver Beaver, Silver Antelope, National Chairman of the Order of the Arrow, member of the Executive Committee of the Birmingham Area Council and, also, the National Council.

He was an active member of the Lutheran Church both on a local and regional basis.

Marshall Crabill Made Manager Of Operations, Indianapolis Water Co.

R. J. Becker Becomes Sup't. of Purification

Marshall P. Crabill was made Manager of Operations of the Indianapolis Water Co., effective December 15, 1955. He had been Superintendent of Purification since 1948. His association with the company began in 1933 when he was employed as an engineering assistant.

Mr. Crabill is a graduate of Purdue University (1932) with the degree of Bachelor of Science in Civil Engineering. He is a member of the Am. Water Works Assn., a past-chairman of its Indiana Section, and has served as chairman of two A.W.W.A. committees. He is also a member of the American Soc. of Civil Engrs., American Public Health Assn., Alpha Tau Omega, is a past president of the "Scientech" Club of Indianapolis and member of the Indianapolis Chamber of Commerce.

Marshall P. Crabill

Robert J. Becker

Robert J. Becker succeeds Mr. Crabill as Superintendent of Purification.

Mr. Becker is a Purdue University graduate (1945) with the degree of B.S. in Mechanical Engineering. He joined the Indianapolis Water Co. in 1948, becoming Assistant Plant Supt. in 1951. He is a member of the Am. Water Works Assn. and secretary of its Indiana Section.

WATER WORKS PRACTICES

Aeration

The Twenty-Seventh of α Series

by GEORGE E. SYMONS, Ph.D.

Dr. Symons is Consultant and Technical Editor, Larchmont, N. Y. In this series he discusses *Water Works Practices* in the form of short course lectures. These are designed to assist plant operators, students, and all who wish to review fundamentals in this field.

THE PROCESS of aeration in water treatment is both unique and commonplace. It may perform one function or several, and the function it is to perform may dictate at what point in the overall purification process it takes place.

This versatility makes it difficult to place the process in any scheme or outline of discussion of water works practices. It is presented at this point, ahead of filtration, because as a process it frequently is used before filtration.

A . . . Basic Considerations

1 . . . DEFINITION

a. Considered from the point of view of unit processes, aeration is a form of gas exchange.

b. In the stricter sense, aeration in water works practice is a process whereby air is brought into intimate contact with water as a means of or adjunct to the improvement of a particular water.

2 . . . PURPOSES OF AERATION

a. Degasification or removal of dissolved gases.

(1) Those which increase the corrosive action of water.

. . . Carbon dioxide (CO_2).

. . . Hydrogen sulfide (H_2S).

(2) Those which interfere with some chemical reaction in water treatment.

. . . Carbon dioxide—softening.

. . . Hydrogen sulfide—chlorination.

(3) Those which are flammable or explosive.

. . . Methane (CH_4).

b. Stripping to remove volatile compounds which cause taste and odor, such as essential oils from algae (not all) and phenols (to limited extent).

c. Oxidation of dissolved chemicals to permit later removal.

(1) Iron compounds.

(2) Manganese compounds.

d. Dissolve oxygen to "freshen" water.

B . . . Theory

1 . . . SOLUBILITY

a. Gas Laws.

(1) Dalton's Law—In a mixture of gases, each component gas exerts a pressure (partial pressure) approximately proportional to its volume percentage.

(2) Henry's Law—The concentration of a gas dissolved in a liquid (water) is directly proportional to the concentration, or partial pressure, of the gas in the atmosphere in contact with the liquid.

HIGH-PRESSURE nozzle aerator

b. Factors in gas solubility.

(1) Partial pressure of gas in the atmosphere.

(2) Temperature of water.

. . . The warmer the water the less gas it will hold.

(3) Other substances dissolved in the water.

. . . Sea water will hold only about 82 per cent as much dissolved oxygen as will fresh water.

2 . . . SOLUTION OF GASES

a. The rate at which a gas will be absorbed in water depends on three factors.

(1) Degree of under-saturation of water with respect to the gas; i.e., saturation deficit.

(2) Temperature.

(3) Extent of intermingling of water and gas; i.e., the extent to which intimate contact is achieved and to which immobile films are prevented at the gas-water interface.

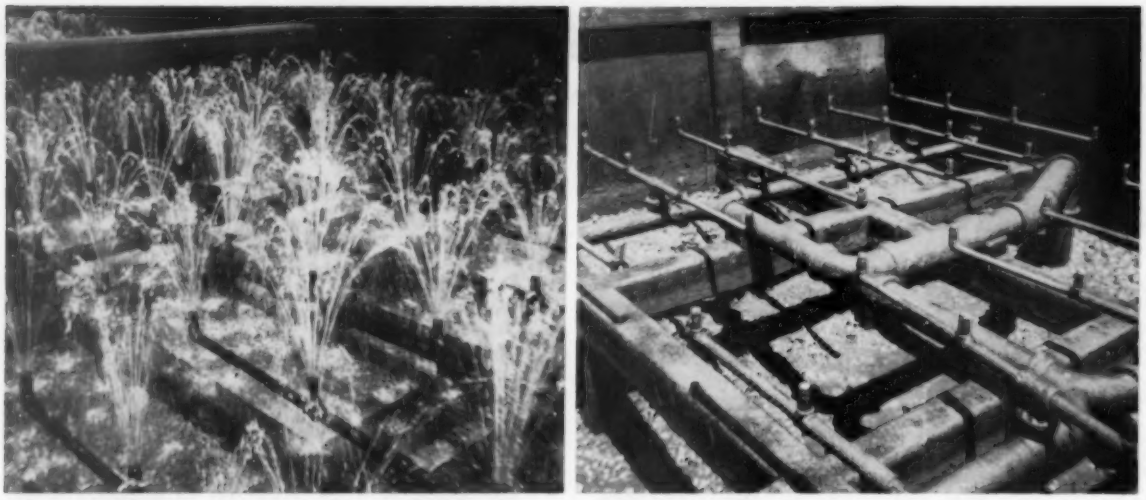
(4) Total amount of solution depends on time involved in transfer operation.

b. Solution of gases in water is expressed by the formula:

$$C_t = S - (S - C_o)\ 10^{-k(A/V)t} \quad \ldots(1)$$

in which

C_t = Actual concentration of gas in water at time t;
C_o = Concentration of gas originally present in water;
S = Saturation concentration of gas in water;
k = Gas transfer coefficient;
A = Area of water-gas interface;
V = Volume of water; and
t = Time period.



SPRAY AERATOR and coke prefilter at Lowell, Mass.

3 . . . Desolution of Gas

a. The rate at which a gas is driven out or can be stripped from water by aeration depends on three factors.

(1) Degree of oversaturation; i.e., saturation surplus.

(2) Temperature.

(3) Extent of intermingling of water and air.

(4) Total amount of gas removed depends on time involved in transfer operation.

b. Desolution or gas release from water is expressed by the formula:

$$C_t = S + (C_o - S)\ 10^{-K(A/V)t} \quad \ldots(2)$$

in which the symbols have the same significance as in Eq. 1.

4 . . . Coefficient of Gas Transfer

a. The rate of gas transfer in either direction is directly porportional to the coefficient k.

b. The coefficient k depends on three factors.

(1) Diffusivity of the gas.

(2) Film resistance.

(3) Temperature.

c. Diffusivity (or molecular diffusion) is a measure of the ease with which dissolved matter diffuses away from the point of solution (interface) to the body of the liquid.

(1) Molecular diffusion is very slow.

(2) It varies with several factors.

. . . It decreases with decreases in temperature and vice versa.

. . . It decreases as the molecular weight increases.

. . . For gases, it varies as the square root of the density.

d. Boundary films occur in both the gas and liquid at the interface.

(1) The resistance to passage of gas molecules across this interface (two boundary films), is controlled by the rate of diffusion and the thickness of the films.

(2) Film thickness and therefore film resistance is decreased by agitation (mechanical mixing or forced intermingling).

e. Temperature affects not only the diffusivity of the gas and film resistance, but also affects solubility of the gas. Therefore, these equations apply only at stated temperatures.

C . . . Types of Aerators

1 . . . Design Factors

a. Important considerations.

(1) Time factor.

(2) Ratio of surface area to volume (A/V in Eqs. 1 and 2).

(3) Method of intermingling air and water.

(4) Power required to operate.

(5) Ventilation.

(6) Safety and corrosion factors.

(7) Limitations.

b. Methods used or type of aerator.

(1) Spray.

(2) Waterfall (gravity).

(3) Injector (diffused air).

c. The factors of time and A/V ratio are controlled by the method used; i.e., the type of aerator and its size.

d. Both spray and waterfall aerators require power to overcome loss of head inherent in this type of aeration.

Diffused air injectors require power to compress the air and force it into the water through small openings some distance below the surface of the water.

e. Open aerators are subject to freezing in nothern climes unless they are housed. If housed, adequate ventilation must be provided to insure effective removal of gases from solution.

f. Enclosed aerators must be ventilated as a safety measure if the gases removed are carbon dioxide (asphyxiant), hydrogen sulfide (poison), or methane (explosive hazard).

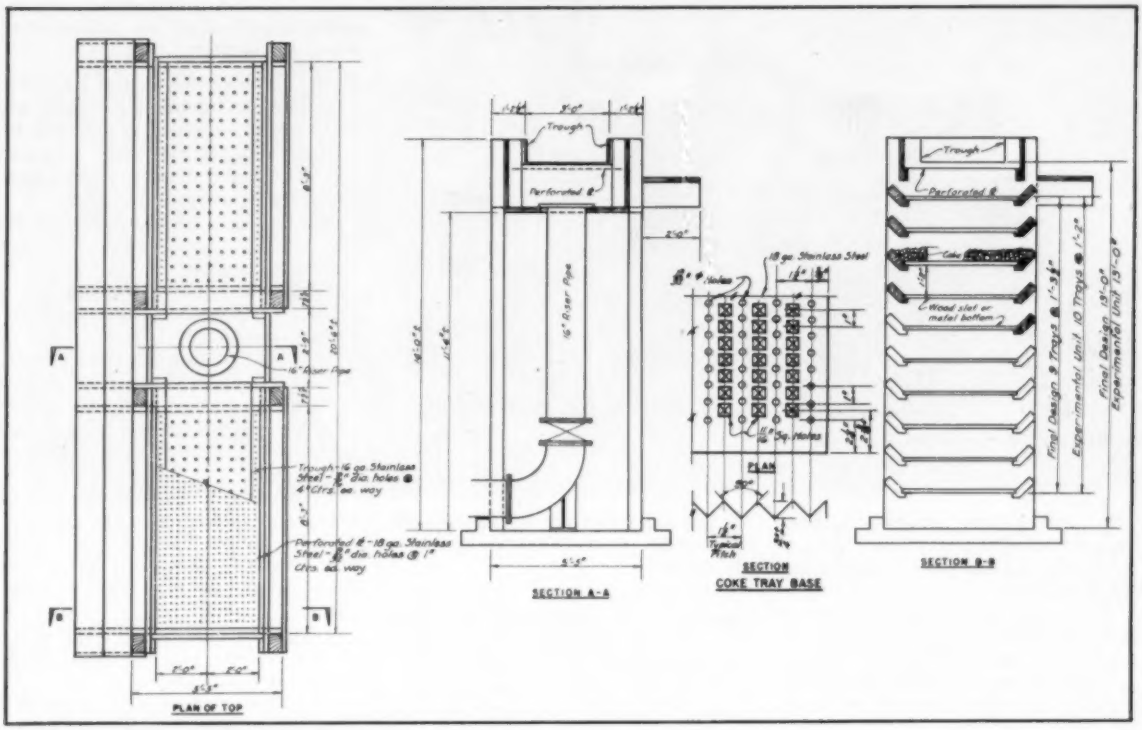
g. Corrosion of the structure and equipment is an ever-present operating problem. Materials used should be those which resist the action of water, oxygen, and carbon dioxide. Concrete, aluminum, asbestos-cement, alloyed steel and creosoted lumber are used. Bronze and cast iron are used in some patented devices. Iron and ordinary steel material should be accessible for painting as needed.

2 . . . Spray Aerators

a. Sometimes termed fountain aerators, these devices consist of nozzles on a pipe grid, through which the water is forced into the air, where it breaks into myriads of tiny droplets.

b. Time of exposure of water to air and ratio of surface area to volume (A/V) depend on velocity with which water leaves the nozzle, nozzle design, height to which water rises, and trajectory of droplets. These factors can be calculated mathematically according to formulas given in Chapter 6 of the AWWA Manual of Water Quality and Treatment, and other standard texts.

c. The nozzle design may vary. Among the different types of nozzles are plain tips, tips which impart whirl-


Trough
Perforated ℄
16" Riser Pipe
Trough - 16 ga. Stainless Steel - ½" Dia. holes @ 4" Ctrs. each way
Perforated ℄ - 18 ga. Stainless Steel - ½" dia. holes @ 1" Ctrs. each way
PLAN OF TOP
SECTION A-A
18 ga. Stainless Steel
PLAN
SECTION
COKE TRAY BASE
Coke
Wood slat or metal bottom
Final Design 9 Trays @ 1'-3½"
Experimental Unit 10 Trays @ 1'-3½"
Final Design 13'-0"
Experimental Unit 13'-0"
SECTION B-B

COKE TRAY aerator design at Memphis, Tenn.

ing motion to the water, rifled nozzles, centrifugal nozzles, impinging devices, floating cones, and rotating reaction nozzles similar to lawn sprinklers.

d. Size, number and spacing of nozzles vary, depending on the head and area available. Nozzles less than 1 inch in diameter may tend to clog. In practice, spacing varies from 2 to 12 ft, discharge from 75 to 175 gpm at 10 psi, and area required from 50 to 150 sq ft per mgd.

e. Spray aerators provide high A/V ratios but short exposure time (about 2 sec) for a vertical jet under a pressure of 10 psi.

3 . . . Waterfall Aerators

a. Sometimes termed gravity aerators or cascade aerators, this type of device depends on raising the water to some elevation and allowing it to flow downward over obstructions, thereby spreading it to produce turbulence in relatively thin layers with changing water surfaces.

b. The design of gravity aerators varies.

(1) Cascade down a concrete step structure.

(2) Thin sheet flowing down an inclined surface studded with baffles to increase turbulence.

(3) Dropping through the air through perforated pans or shallow trays, or over weirs at the edge of trays.

(4) Percolation through porous materials, such as slats, coke, stone, ceramic balls, etc.

(5) Combinations of multiple trays with or without percolation media.

c. Cascade aerators usually require from 3 to 10 ft of head and the floor area required may vary from 30 to 50 sq ft per mgd.

d. In multiple tray aerators spacing is from 12 to 30 in. apart and the area required is usually less than 30 sq ft per mgd. Usually three to five trays are used, with the head required ranging from 3 to 12 ft depending on the spacing and number of trays.

Contact time and A/V ratio can be increased simply by adding more trays at the cost of higher operating head required.

4 . . . Injector Aerator

a. Advantages.

(1) Longer aeration time can be provided, than in gravity aerators, for the same expenditure of energy.

(2) Head is conserved.

(3) Not subject to freezing.

b. Disadvantages.

(1) Higher initial costs.

(2) Higher maintenance costs.

(3) Lower turbulence, lower A/V ratio and greater surface film thickness than in gravity filters.

c. Design.

(1) Diffused air aerators are generally in rectangular concrete tanks from 9 to 15 ft wide and 10 to 30 ft deep.

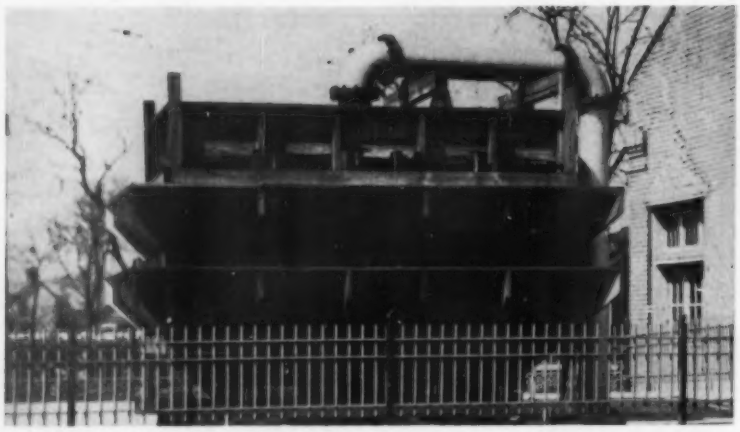
. . . Ratios of width to depth are usually no more than 2 to 1, and the desired aeration time governs the tank length, with a detention time of 10 to 30 min. being common.

(2) The injector may be a perforated pipe, porous diffuser plate, porous diffuser tube, impingement device, or other mechanism for breaking up air into small bubbles after it is introduced into the bottom of the tank.

. . . The diffusers or injectors are often placed along one side of the tank to impart a spiral flow and thus create turbulence and improve gas transfer.

. . . Porous or perforated tubes may be suspended at about half-depth to reduce power requirements for compression. Porous plates are placed at the bottom of the tank.

d. Power requirements average 1.0 kw per mgd capacity (range 0.5 to 2.0 kw) and blower pressure depends on depth of water over the diffusers and the line head loss from blower through diffusers.



COKE TRAY aerator at Coraopolis, Pa.

e. The amount of air required varies from 0.01 to 0.15 cu ft per gal, depending on the purpose and treatment required.

f. Because porous tubes and plates will clog with foreign matter in the air, a filter of some type is required on the incoming air to the compressor. Filters may be electrostatic units or of metal wool, glass, or hair impregnated with oil, or other special materials.

g. Space required for injector aerators is less than that for spray aerators and more than that for waterfall type aerators.

5 . . . Proprietary Devices

a. Several equipment manufacturers have developed and patented special aerator devices. Among these are the "Aero-mix," "Cavitator," "Diffusair," etc.

b. For information on companies making patented aeration apparatus, reference should be made to the "Classified Index of Products" in the annual "Reference and Data Edition" of *Water & Sewage Works*.

c. Blowers or compressors are necessary adjuncts to diffused air aeration. Information on the selection and operation of such equipment is best obtained from the manufacturers whose name may be found under "Blowers" in the "Classified Index of Products," "Reference and Data Edition" of *Water & Sewage Works*.

D . . . Applications of Aeration

1 . . . Carbon Dioxide Removal

a. Carbon dioxide is removed to reduce corrosivity of water or in softening plants to reduce the lime requirement for softening.

b. Maximum aeration to produce equilibrium with the CO_2 content of the air will reduce the CO_2 content of the water to from 0.3 to 2.0 ppm, depending on temperature and CO_2 in the air.

(1) If bicarbonate alkalinity is present to 50 ppm, prolonged aeration will reduce about 14 per cent of the bicarbonate to carbonate.

. . . If 200 ppm or more of bicarbonate alkalinity are present, aeration to equilibrium will actually precipitate some calcium carbonate.

(2) Aeration to the equilibrium point with the atmosphere is not economical.

. . . In industrial plants the practical limits are a residual of 5 to 15 ppm of carbon dioxide.

. . . In municipal softening plants it is generally cheaper to remove less than 10 ppm of carbon dioxide by lime treatment than by aeration. Cost of lime and power affect this relation.

c. Types of aerators used and results.

(1) Choice depends on

. . . CO_2 content of water.

. . . Per cent removal required.

. . . Presence of iron and manganese.

. . . Volume of water to be treated.

(2) In municipal water plants, reports indicate

. . . Spray aerators will remove 70 to 80 per cent of CO_2, even as high as 90 per cent.

. . . Cascade aerators, from 44 to 55 to 27 to 34 ppm at Champaign-Urbana, Ill.; and from 18.6 to 10.4 ppm at Ames, Iowa.

(3) In industrial plants

. . . Coke or wood slat tray for small CO_2 content.

. . . If no iron or manganese removal problem, use spray, step, plate or riffled cone type of aerator.

. . . If CO_2 content high, or high removal required, use enclosed forced draft degasifier.

. . . When iron and manganese removal also desired, use coke-tray or wood slat aerator.

2 . . . Hydrogen Sulfide Removal

a. Few sulfur-bearing waters are used for municipal supplies, but industrial supplies may have to resort to sulfur water sources. Even 1 ppm has a highly disagreeable odor.

b. Hydrogen sulfide is more soluble than carbon dioxide and therefore harder to remove.

(1) As CO_2 is removed the pH is raised, which makes it even more difficult to remove H_2S.

(2) Two-stage treatment is best.

. . . First stage (top half of gravity aerator) is treated with a mixture of stack gases (high in CO_2) and air to keep pH low and H_2S removal high.

. . . Second stage (bottom half of aerator) receives air to which no CO_2 is added, for the purpose of removing CO_2 originally present or dissolved during first stage of treatment.

c. Small amounts of residual hydrogen sulfide may be removed by treatment with chlorine.

(1) One ppm of H_2S requires 2 ppm of chlorine to oxidize it to free sulfur.

(2) One ppm of H_2S requires 8.32 ppm of chlorine to oxidize it to sulfate.

3 . . . Methane Removal

a. Waters containing methane are uncommon, but where it occurs, it does constitute a fire and explosion hazard.

Such waters should always be aerated.

b. The solubility of methane in water is about one-half that of pure oxygen, which means that the maximum CH_4 content of water in contact with a methane atmosphere would be approximately 20 ppm, but since it does not combine with water in any way it is easily removed by methane-free air.

c. Open-type aerators with good circulation of air are best, the wood-slat tray aerator being the most used. It should be located in an open spot away from fires or sparks which might lead to explosions.

4 . . . Taste and Odor Removal

a. Some odors which occur in water, either naturally or from industrial wastes, can be removed by aeration.

b. Removal of odors by aeration depends entirely on the volatility of the substance causing the odor. If the volatility is high enough, aeration will be effective for removal.

c. Essential oils released from

WOOD SLAT TRAY aerator on roof for iron removal

algae are not highly volatile. Only about 50 per cent removal is possible for some of the most objectionable odors, for example, *Synura*. Removal in cold weather is much lower than in the summer season.

d. Many plants use aeration to remove part of the odors and follow with activated carbon treatment to complete the job.

e. Not only does aeration have its limitations for odor removal, but it also may create other difficulties. These are discussed later.

f. Types of aerators used may include all of those discussed heretofore except that coke tray and slat types are not common in municipal supplies. In at least one instance where industrial waste odors predominate with threshold odors up to 6,000 (Nitro, W. Va.), high-pressure (55 psi) spray aeration is used followed by recirculation and spray at pressures of 24 psi. Almost complete odor removal is accomplished.

5 . . . Oxygenate Water

a. Some ground waters devoid of oxygen have a "flat" taste to the consumer. Aeration will usually "freshen" this type of water.

b. Water devoid of oxygen, when introduced into a system previously tuberculated by oxygen-bearing water, will cause red water troubles.

c. There are relatively few applications of this type.

6 . . . Iron Removal

a. Aeration to remove iron from waters is a common practice in both municipal and industrial supplies.

b. Oxidation of the ferrous iron (usually ferrous bicarbonate) to ferric hydroxide converts a soluble substance into an insoluble one which can be removed by sedimentation and filtration.

(1) The pH of the water is important to the operation. Above pH 7.0 the reaction is fast enough for normal aeration periods, but at low pH values oxidation is considerably slower and neutralization is necessary.

(2) Theoretically it requires only 1/7 ppm of oxygen for each ppm of iron removed.

c. Eighty per cent of iron-bearing waters contain less than 5 ppm of iron; few contain more than 20 ppm.

(1) Therefore, the normal dissolved oxygen content of water is sufficient to oxidize all of the iron present.

(2) Aeration reduces CO_2 content and increases pH, both effects tending to aid the desolution of iron.

d. Aeration followed by sedimentation should reduce the iron content of water to less than 0.1 ppm as Fe; this is satisfactory for both municipal and industrial uses.

e. Types of aerators used:

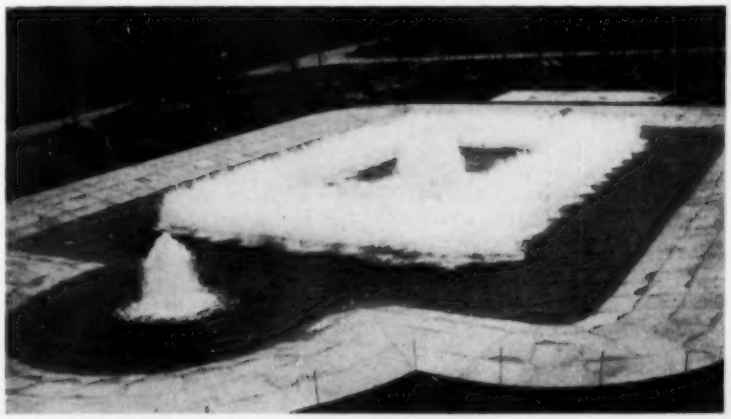
(1) Most widely known is the coke-tray aerator. It is not the most efficient, but serves well and the coke is easily and cheaply replaced when it becomes clogged with iron deposits.

(2) Other types of aerators are just as effective.

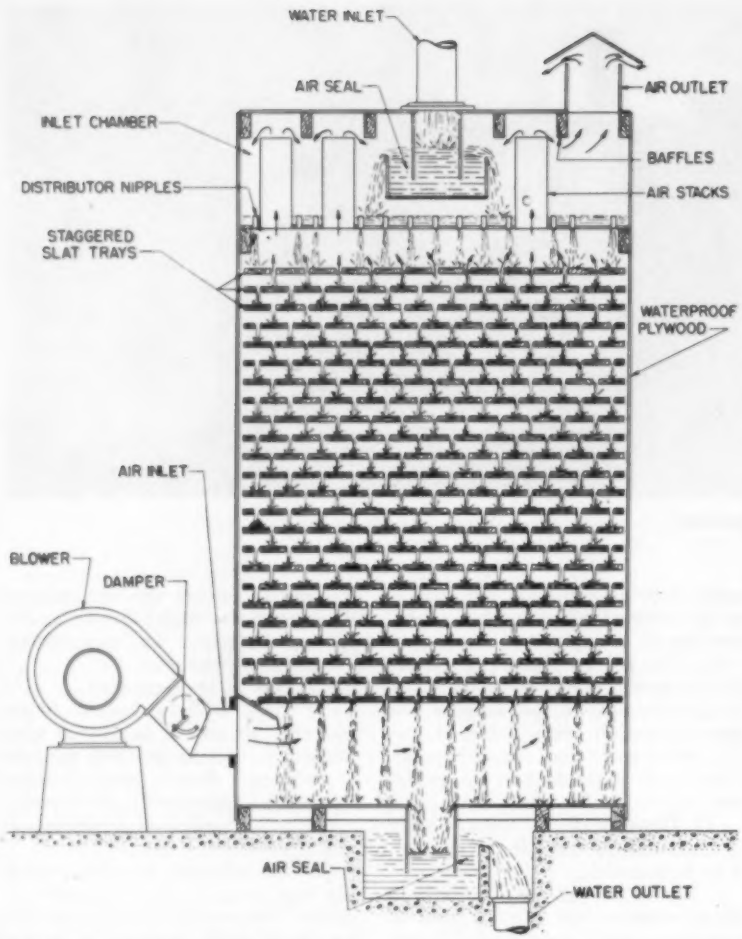
(3) In industrial supplies, wood-slat tray aerators are frequently installed. Occasionally, a pressure-type aerator is used when it is desired to handle water under pressure, but the iron and CO_2 content cannot be high in such cases.

7 . . . Manganese Removal

a. Manganese generally occurs in natural waters as the manganous bicarbonate. It can be removed by aera-



JET AERATORS at Providence, R. I.



SECTION through rectangular degasifier *(Courtesy Permutit Co.)*

tion, settling, and filtration.

b. Oxidation of manganese requires a relatively high pH, preferably above 10.0, but oxidation will be complete since 1.0 ppm of oxygen will oxidize 7.0 ppm of manganese.

c. From a practical standpoint, it is necessary to add lime or caustic soda to provide the desired pH.

(1) At pH 9.0 to 9.5 most of the manganese will come out of solution.

(2) What is left can be removed on "ripened" filters, which contain a previously precipitated manganese dioxide coating on the sand grains.

d. If iron is also present, it will precipitate first during aeration. If organic iron and manganese are present, coagulation may be needed, as well as aeration, since organic matter tends to "hold up" both iron and manganese.

8 . . . Operation Problems

a. Corrosion.

(1) In some instances the introduction of dissolved oxygen by aeration makes the water more corrosive.

(2) Aeration to remove CO_2 before softening and iron removal at Lansing, Mich., increased red water troubles in home hot water systems. Removal of CO_2 by lime instead of aeration relieved the problem.

b. Odor Removal.

(1) Many plants report that aeration is only partially effective on algae odors; some report no removal at all with aeration.

(2) A few plants, particularly in Ohio, have reported that aeration actually increased the threshold odor value in the water.

c. Contamination.

(1) Aeration of well waters as the only treatment may actually cause contamination of the supply.

(2) In West Palm Beach, Fla., aeration apparently was contributory to chironomids laying eggs on the water surface in the basins, with the result that the hatching bloodworms appeared in the consumers' taps. Aeration was discontinued.

(3) One plant employing a spray aerator with a discharge height of 12 to 14 ft, showed coliform organisms in the plant effluent although the influent contained none.

d. Cost.

(1) Power to operate aerators of all types may be no small operating cost. Calculations for one plant indicate that for 80 per cent efficiency it costs $0.39 per mil gal to remove 1 ppm of CO_2.

(2) Such operating costs should always be compared to the cost of chemicals for the same job. In this case, chemical removal of 1 ppm would cost approximately $0.09 per mil gal.

(3) When aeration is solely for taste and odor removal, it may be found that small increases in chemical dosage will produce the same or even better results at little more cost than for aeration.

E . . . Deaeration

1 . . . Reasons

a. Removal of oxygen dissolved in water is not practical or necessary in municipal supplies.

b. Removal of oxygen, carbon dioxide and nitrogen is practiced in preparing boiler feedwater, and for some industrial uses, to eliminate corrosion.

2 . . . Methods

a. Hot method equipment.

(1) Open spray-type heaters.

(2) Closed deaerating spray-type heaters, both vertical and horizontal.

(3) Deaerating heaters, both tray and atomizing types.

b. Cold water deaeration is accomplished by subjecting the water to vacuum, which may be created by steam ejector or vacuum pump. The dissolved oxygen content can be reduced to 0.3 ppm in this type of apparatus.

c. Chemical deoxygenation using sulfites or other reduced compounds.

F . . . References

Material for this lecture was obtained from the following reference texts:

AWWA—"Manual of Water Quality and Treatment," Chapter 6 Revised, JAWWA, *47*, 873 (1955).

Babbitt & Doland—"Water Supply Engineering," 5th Ed. (McGraw-Hill).

Fair & Geyer—"Water Supply and Waste-Water Disposal" (John Wiley & Sons).

Nordell—"Water Treatment for Industrial and Other Uses" (Reinhold Pub.).

Next Lecture—Filtration.

Dollar Savings Through A Sound Safety Program

by WENDELL R. LaDUE

Mr. LaDue is Chief Engineer and Superintendent of the Bureau of Water Supply, Akron, Ohio. This article is adapted from a paper presented by Mr. LaDue before the Water Utilities Section of the National Safety Council.

ALTHOUGH the title of this paper may sound as though it could develop into a mercenary approach to a very human problem, such could not be farther from the truth, either by implication or intent.

At the start, consider a very hypothetical, but nevertheless by no means unusual or impossible, industrial accident case—say of Sam Brown. It has been Mr. Brown's grave misfortune to have lost an eye. The details of the accident are matters of record, and regardless of all statements as to possibilities, Mr. Brown is still at the position where one of his eyes has been irretrievably lost. The proper body of the Industrial Commission of the state has reviewed the facts, statements, and exhibits, and has determined that Mr. Brown has sustained a permanent partial disability, worthy of cash compensation to the amount of several thousands of dollars. The case is closed.

Many of Mr. Brown's friends and fellow employees have said, with a striking degree of reality: "Can anyone or any group set a money value on such a loss?" Truly no one or no group can answer in the affirmative. In fact, Workmen's Compensation has never been considered, nor can it be, a payment in full restitution. As in all types of insurance—fire, life, health, accident—the best it can do is to recognize the frailties of human nature and the inadequacies of solutions of very personal problems and, at best, try to compensate for a loss by recognizing that there always will be those who care.

In Sam Brown's case everybody connected with the case lost. Every disabling injury sets up a chain reaction which spreads and envelops a convincing array of contacts, developments and reactions.

There are direct costs; compensation premiums, doctor bills — both medical and surgical—hospitalization and nursing fees.

Indirect costs by the dozens include loss to the employee, the employer, and his fellow workmen, as follows:

1. Losses to the employee:
   (a) Loss of wages due to time lost from work.
   (b) Drain on the economic position of the family due to unusually large bills.
   (c) Eventual permanent reduction in the injured employee's ability to continue to provide for his home and his family.
2. Losses to the employer:
   (a) Loss of a valued and efficient employee.
   (b) Break-up of the team-work of a work crew.
   (c) Disruption of production by damage or lay-up to valuable machinery, tools, and equipment.
   (d) Disruption of time and productive efforts of the supervisor and cooperating employees.
   (e) Loss of stock due to shut-down.
3. Losses to the fellow employee:
   (a) Loss of time due to shut-down.
   (b) Loss of wages due to loss of work.
   (c) Reduction in productive power due to the loss of a valuable member of the team.

From this brief outline it can be observed quite readily that dollar loss is only a part of the reaction. Every disabling injury imposes direct financial loss to the employee (the victim), to the fellow employees, to the utility, and indirectly to each customer of the utility. Yet dollar loss has proven to be the incentive by which some measure of relief has developed.

At the outset attention was called to a hypothetical industrial accident case, for instance, operating under the laws of the State of Ohio. One clause of the law is worthy of inclusion here as follows:

Section 1465-83 G.C. (4123.39 R.C.)

The amount of money to be contributed under section 4123.38 of the Revised Code by the State itself and each County, and each taxing district within each County shall be determined by the Industrial Commission. In fixing the amount of contribution to be made by the County, for such County, and for the taxing districts therein, the Commission shall classify Counties and other taxing districts into such groups as will equitably determine the contributions in accordance with the relative degree of hazard, and shall also merit rate such individual counties, taxing districts, or groups of taxing districts in accordance with their individual accident experience so as ultimately to provide for each taxing subdivision contributing an amount sufficient to meet its individual obligations and to maintain a solvent public insurance fund.

Most business managers of water utilities are familiar with the techniques of procedure of Industrial Commissions. Nevertheless, most represent utilities which have not yet taken advantage of the clauses in the law which lead to "dollar savings" and "discount rates." In other words, can it be said that the full "merit rating" provided has been earned? To be sure some have earned part of it; but much more can be gained. Table 1 shows how this has been effected by the Akron water utility during the past eight years. The table shows $29,022.94 saved in eight years, and, to refer back to 1937, a reduction in the premium from $2.28 to $0.74 per $100 of payroll, a reduction of $1.54 or 67.5 per cent.

How the Individual Worker Benefits

The individual workman might ask: "How does this help me?" It does, in a very real manner, as follows:

First, it provides the funds to support a real, live safety program.

Second, a real live, safety program will inevitably reduce accidents through the application of well-proven sound, safety measures.

Third, reduction in accidents means fewer employees who will be called upon to suffer and to lose time.

TABLE 1

Comparison of Workmen's Compensation Premium Rates of All Ohio Cities and City of Akron

Year	Water Dept. Payroll, $	All Cities Base Rate, $ per $100	Premiums at City Base Rate, $	Akron Rate, $ per $100	Akron* Premium, $	Savings to Water Dept., $	Savings, % of Base
1947	491,706	0.65	3,196.09	0.59	2,901.07	295.02	9.2
1948	574,347	0.65	3,733.26	0.53	3,044.04	689.22	18.5
1949	635,335	0.65	4,129.68	0.50	3,176.67	953.01	23.1
1950	660,992	0.80	5,287.94	0.54	3,569.36	1,718.58	32.5
1951	738,433	0.94	6,941.27	0.51	3,766.01	3,175.26	45.7
1952	817,260	1.03	8,417.78	0.55	4,494.93	3,922.85	46.6
1953	924,558	1.55	14,330.65	0.74	6,841.73	7,488.92	52.3
1954	962,507	1.86	17,902.63	0.74	7,122.55	10,780.08	60.2
Total	5,805,138	.....	63,939.30	.....	34,916.36	29,022.94	45.4

* Water Department.

Fourth, less lost time through fewer accidents means greater production, higher payroll, increased efficiency.

In short, everybody wins, for "the accident you prevent may be your own." And, again, fewer accidents reduce compensation premiums, to provide funds to inaugurate safety programs to prevent accidents. Money thus saved and "plowed back" into a safety program helps the employer, the employee, and the utility—another evidence of a chain reaction.

Is This an Undue Burden on Management?

Does not this place an undue burden on utility management? Not at all. Some lazy utility managers may think so, but since a good safety program is part and parcel of the overall problem of conducting a successful business, it will force recognition and acceptance upon any manager. It is just as important as selecting a proper commodity, a suitable building site, or the purchase of necessary tools, equipment and materials.

Therefore, a positive demand on the part of the chief executive of a water utility will, of course, be translated into an equally active interest on the part of supervisors through the usual channels of training, upgrading, persuasion, and other conventional devices by which executive orders get carried out. The specific procedures and materials for creating and maintaining interest in safety are available from the National Safety Council, insurance companies, the U. S. Department of Labor, the American Water Works Association, and other authoritative sources.

Safety is a plan for living—a philosophy of life, whereby the well-ordered individual adds to the sum-total of a satisfying life. The safe workman considers in his approach to a job of work, not only proper tools, necessary equipment and selected materials, but also a *safe* plan for its execution. A job cannot be accomplished properly unless it is concluded safely. Safety-mindedness is a product of self-discipline, good instruction, proper direction and continuous exemplification.

Does it follow that a safety program is good business? Obviously. If safety programs were not good business, the wealthiest, most powerful, most competitive water utilities in the world would not be increasingly supporting them with larger and larger budgets for the setting up of safety departments, the hiring of trained personnel, and the insistence upon safe procedures in personnel processes.

Safety programs are even more than good business: they are good employee relations, good public relations, and good protection against legislative control. A utility which has its house in order need not fear the approach of authority to make it so.

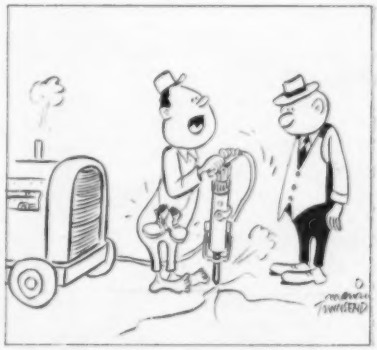
Yes, SAFETY does produce dollar savings, and dollar savings are put to work — to the greater safety and greater benefit of employee and employer alike.

Vertical Pump Industry Manual Available

What is claimed to be one of the most complete and authoritative reference books ever issued in the vertical turbine pump industry was recently issued by Johnston Pump Company. This new 392-page manual discusses pump selection for hot, volatile, viscous and corrosive fluids, applications, engineering formulas and data. The development of ground water resources, geology, drilling methods, well logging, construction, design and performance characteristics of vertical turbine, mixed flow and propeller pumps, and many other factors are analyzed.

Specific papers have been contributed to the book by many leading world authorities, including E. W. Bennison, engineer of Edward E. Johnson Co., Inc.; R. R. Smith, F. M. Smith and A. H. Miller of Duralmetallic Corp.; C. W. Joseph, Chemstrand, Inc.; Herbert Goyod of Well Instrument Developing Company; and many other experts.

This carefully indexed manual of the vertical pump industry in one volume outlines basic design principles and operating characteristics and gives examples to show their practical applications. It may be obtained from: Johnston Pump Company, 3272 E. Foothill Blvd., Pasadena, California, at $10.00 per copy.



"Sometimes these here paving breakers slip, and I ain't going to risk getting a hole punched through my new shoes."

Effect of Synthetic Detergents on Chemical Coagulation of Water

by DAVID H. HOWELLS and CLAIR N. SAWYER

Mr. Howells, Senior Assistant Sanitary Engineer, U. S. Public Health Service, Chicago, Ill., performed the work on which this paper is based while a graduate student at Massachusetts Institute of Technology under the guidance of Dr. Sawyer, Professor of Sanitary Chemistry. The study reported here was made on a naturally colored water.

CONSUMPTION of synthetic detergents during the past few years has increased enormously, there having been a significant increase in use even in soft water areas. The trend towards greater utilization of synthetic detergents has been accompanied by a corresponding increase in operational difficulties at some sewage treatment and water purification plants.

Although all the principal anionic and nonionic synthetic detergents are susceptible to some degree of biological degradation, there is considerable variation in individual susceptibility, both among members of the same chemical type and among different detergent classes[1]. It is apparent, therefore, that a large proportion of the synthetic detergents entering a sewage treatment plant in the raw sewage is discharged in the plant effluent to the receiving stream.

Sawyer *et al*[2] have found the half-life of one of the popular syndets to be in the order of 15 days in stream waters under summer conditions. The fact that the concentration of surface active agents from synthetic detergents could reach 12 ppm in the Ohio River[3] is further evidence that rapid degradation of many synthetic detergents does not occur in the stream.

In addition to surface active agents, the complex phosphates are important constituents of almost all commercial detergents. These do not form insoluble materials in sewage and tend to pass through present-day treatment plants[4].

Nearly all rivers used today as sources of municipal water supply contain considerable treated and untreated sewage. In a river such as the Ohio River, the water is used over and over again before its eventual discharge to the sea. Under such circumstances, it is inevitable that the concentration of synthetic detergents not subject to rapid biological degradation would continually increase with each additional discharge of waste. Such waters might be expected to produce operational problems when treated in modern water purification plants.

Haney[5] has made an excellent summary of the effects of synthetic detergents on water purification at several places in the United States where conditions have become critical on occasion.

Syndet Production

Sales of synthetic detergents continued to gain during 1954, making a further inroad on the soap market. However, the increase in sales of synthetic detergents was only 11 per cent in 1954, as compared with 22 per cent in 1953. There is indication that the tremendous boom in synthetic detergents is slowing down as the potential market decreases.[6] Sales figures for soaps and synthetic detergents during the past three years are given in Table 1.

Previous Experimental Studies

There have been many published accounts of difficulties experienced in the chemical coagulation of water which have been attributed to synthetic detergents. In most instances, varying concentrations of surface active agents were found to be present in the raw water supplies, and the operational problems were related to the broad category of "synthetic detergents."

The literature contains no account of any comprehensive investigation to determine the relative effects of the various types of surface active agents and builder compounds upon chemical coagulation, or to identify the particular components of synthetic detergents responsible for coagulation difficulties.

The first investigation into this problem was carried out in 1950 by Cross[7] at the Chicago South District Filtration Plant, where he investigated the effect of three industrial and three domestic synthetic detergents on the chemical coagulation of Lake Michigan water. None of the six detergents was identified in the published account of this work. Synthetic detergents were added to the water in sufficient quantity to produce concentrations ranging from 0.1 to 5.0 ppm. Interference with coagulation was measured by visual observation of the quality of the floc. When interference did occur, it usually was not until the 5.0-ppm concentration of synthetic detergent was attained.

The domestic synthetic detergents caused considerably more interference with coagulation than did the industrial synthetic detergents. Tests conducted with ferric sulfate and chlor-

TABLE 1

Soap and Synthetic Detergent Sales*

(millions of pounds)

Item	Year		
	1952	1953	1954
Soaps other than liquid	1,824	1,605	1,428
Synthetic detergents	1,530	1,867	2,067
Total	3,354	3,472	3,495

* Reference 6.

TABLE 2
Synthetic Detergent Products

Trade Name	Manufacturer	General Type	Presumed Surface Active Agent*
Vel	Colgate	Anionic	A.B.S.
Dreft	Procter & Gamble	Anionic	A.S.
All	Monsanto	Nonionic	P.O.E.
Tide	Procter & Gamble	Anionic	A.B.S. & A.S.
Surf	Lever Bros.	Anionic	A.B.S.
FAB	Colgate	Anionic	A.B.S.
Cheer	Procter & Gamble	Anionic	A.B.S. & A.S.
Oxydol	Procter & Gamble	Anionic	A.B.S.
Glim	Babbitt	Nonionic	A.P.P.O.
Joy	Procter & Gamble	Nonionic	A.P.P.O.

* Surface active agents (Ref. 9): A.B.S. = alkyl benzene sulfonate; A.S. = alkyl sulfate; A.P.P.O. = alkyl phenoxy polyethylene oxide; P.O.E. = polyethylene oxide ester.

inated copperas as coagulants gave results similar to those utilizing alum. The phenomenon of rising floc was experienced when a domestic synthetic detergent in concentrations of 1.3 and 5 ppm was used. The floc was observed to be buoyed up by "small air bubbles." At the end of a 2-hour settling period all the floc had risen to the surface.

A later investigation was made by Langelier and associates[8], in which they studied the effects of certain surface active agents and a glassy phosphate upon alum coagulation in synthetic turbid waters. They reported that one anionic surface active agent (an alkyl aryl sulfonate) caused no effect in the flocculation phenomenon in concentrations as high as 50 ppm.

Another alkyl aryl sulfonate was observed to have no effect on flocculation in concentrations up to 17 ppm, but caused increasing dispersion above that level, reaching a complete dispersion at a concentration of 40 ppm. This dispersing action was completely overcome, and the floc actually improved as to size and density, by increasing the alum dosage from 25 to 30 ppm.

A third anionic surface active agent increased coagulant demand from 25 to 50 ppm of alum at 0.005 per cent concentration by volume and to 100 ppm alum in a concentration of 0.01 per cent by volume.

Of the nonionic surfactants studied, one polyoxyethylene thioester caused no interference with flocculation in a concentration of 0.06 per cent by volume and a polyoxyethylene ester had only a slight effect on the flocculation phenomenon in a concentration of 2.0 per cent by volume. Another nonionic surface active agent caused complete dispersion of a system that otherwise would have produced an excellent floc.

Langelier and associates also conducted studies on the effect of the sequestering agent, sodium metaphosphate, on alum flocculation. Although the metaphosphates are not commonly used as synthetic detergent builders, their close chemical and physical relationship to other complex phosphates extensively used as builders makes this work of interest. They reported[8] that the alum dosage increased linearly as the concentration of metaphosphate increased. The quality of the floc produced at the most efficient dosage was found to decrease as the concentration of the metaphosphate increased. At a sodium metaphosphate concentration of 5 ppm or more, normal alum flocculation could not be obtained, regardless of the amount of alum added.

A study of the removal of phosphates from sewage by chemical coagulation with ferric sulfate, alum and other coagulants was conducted by Sawyer[4] in 1951. This work is of interest because of the observed coagulant demand exerted by tetrasodium pyrophosphate and sodium tripolyphosphate, both heavily used as synthetic detergent builders.

TABLE 3
Commercial Surface Active Agents Studied

Class	Type	Agent	Product
Anionic	Alkyl aryl sulfonate	Keryl benzene sulfonate	Procter & Gamble A-335897
		Propylene tetramer benzene sulfonate	Procter & Gamble UX J-1-166b
	Alkyl sulfate	Sodium dodecyl sulfate	Procter & Gamble sodium dodecyl sulfate
	Sulfonated amide	———	Antara Chem. Co. Igepon T-77
	Sulfonated ester	———	Antara Chem. Co. Igepon A-P-78
Nonionic	Alkyl phenoxy polyethoxy ethanol	———	Antara Chem. Co. Igepal CA-630
	Polyethoxy ethanol fatty acid ester	———	Armour Ethofat 60/60
	Polyethoxy ethanol fatty acid amide	———	Armour Ethomid HT/60
	Polyethylene glycol	———	Wyandotte Pluronics F-68

Experimental Materials

Synthetic detergents studied included eleven representative retail products packaged for domestic use. These synthetic detergents, together with manufacturer, classification, and presumed surface active agent, are as shown in Table 2.

Also, a commercially available surface active agent of each important type of the anionic and nonionic classifications was studied. These were as given in Table 3.

Building compounds studied included those in greatest use in the compounding of commercial synthetic detergent products. These were sodium sulfate, sodium tripolyphosphate, tetrasodium pyrophosphate, and carboxymethylcellulose (Wyandotte).

Water, Coagulant and Equipment

Water used in the experimental work was taken from Fresh Pond, a raw water storage reservoir for the city of Cambridge, Mass. This body of water is a natural lake located in the western end of the city. It has as its source the natural runoff of the

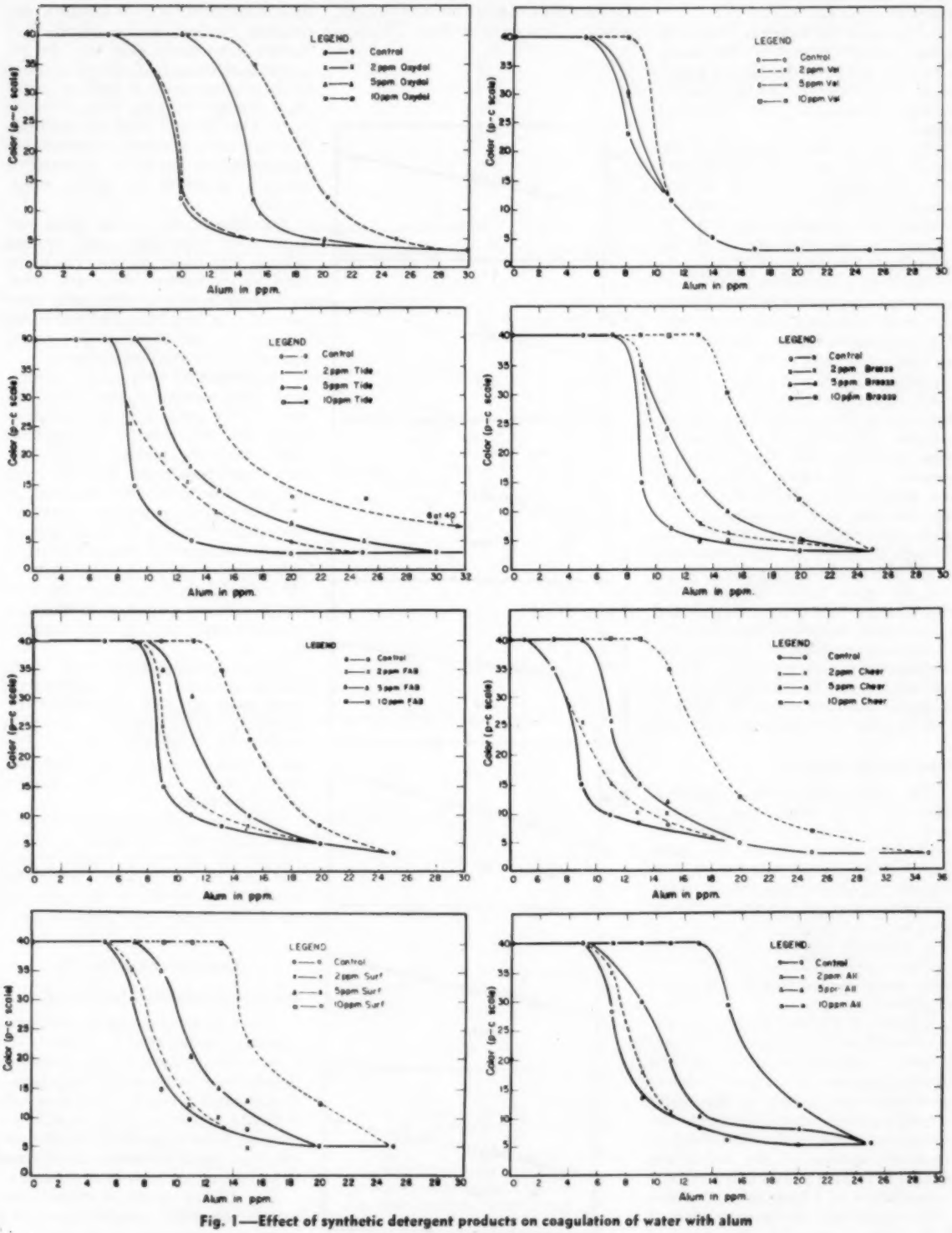


Fig. 1—Effect of synthetic detergent products on coagulation of water with alum

small (1.25 sq mi) Fresh Pond watershed, ground water, and some of the excess runoff of the Stony Brook reservoir.

Pollution of the water is limited to surface runoff. Therefore, the water is free of synthetic detergents which would be present in surface waters receiving municipal and industrial wastes.

The natural color content of the water varied between 25 and 40 color units throughout the period of this investigation. During the same time interval the pH ranged from 6.7 to 7.4 and the total alkalinity varied between 24 and 34 ppm as $CaCO_3$.

Chemical coagulation tests were conducted in round, 2-liter battery jars using a standard laboratory stirring machine with glass paddles. Filter alum was used as the coagulant. A plastic baffle 1 inch wide was fitted to the side of each jar to improve the flocculating characteristics of the jar.

Color determinations were made with platinum-cobalt color standards prepared in accordance with "Standard Methods"[10]. Suspended matter was removed from the water prior to color determination by filtering through 2 inches of sand contained in a 1¼-inch diameter glass tube.

A Beckman Model 2H pH meter was used for pH determinations and electrometric titrations for alkalinity. Phosphorus analyses of synthetic detergents and complex phosphate builders were made by the colorimetric-stannous chloride method[10], using a Coleman Model 14 spectrophotometer.

Experimental Technique

The water used in the coagulation tests was taken from Fresh Pond at such a frequency that no water remained in the laboratory for more than 36 hours before being used. Water was stored in glass carboys under refrigeration until 12 hours before tests were conducted, at which time it was removed and allowed to warm to the room temperature of 24°C. All tests were carried out at this temperature.

Individual 1.5-liter samples of water were placed in the coagulation jars 1 hour in advance of each run. The desired quantity of synthetic detergent was then added to the water through use of a stock solution of the compound prepared the day before. A thorough mixing of the water and synthetic detergent was followed by a contact time of 1 hour prior to chemical coagulation. At the expiration of this 1-hour period, the required amount of alum was added from a stock solution of this compound. After a 30-second period of rapid mixing, the samples were agitated on the stirring machine at 45 rpm for 20 minutes. Following flocculation, the samples were given a 30-minute period of quiescent settling. This was followed by analyses for color, pH, and alkalinity.

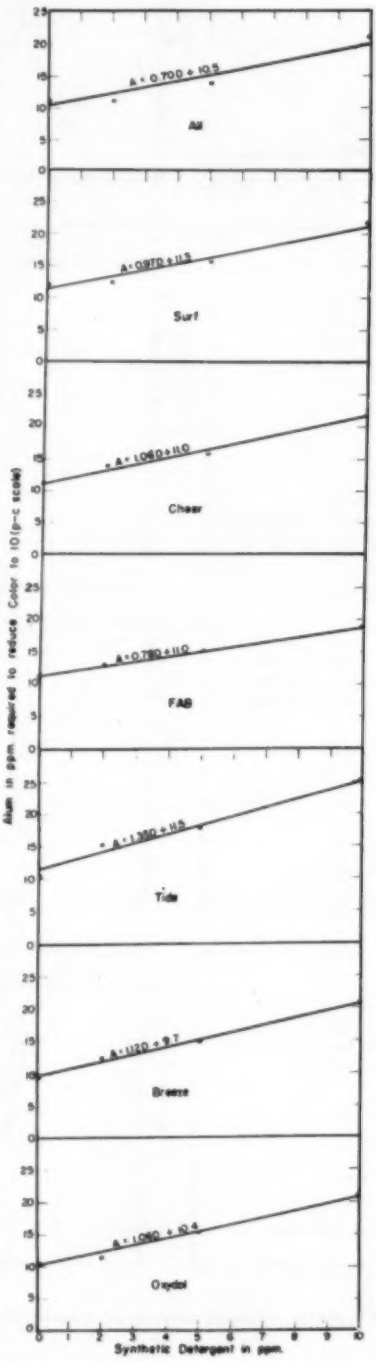


Fig. 2—Relationships of synthetic detergent concentration to alum requirements

Four series of coagulation tests were conducted for each synthetic detergent, surface active agent and builder. One series each was run on water containing 0, 2, 5 and 10 ppm of these compounds at eight or more alum dosages ranging from 5 to 30 ppm. The 10-ppm level of synthetic detergents was selected as a maximum amount which would be expected to occur in water fit for public water supplies.

The appearance of the alum floc during the flocculation and settling periods was observed for variations between the control series and those containing synthetic detergent compounds as a supplementary means of determining the effect of these compounds on chemical coagulation.

The extent of removal of the natural color content of the water was used as the primary means of measuring the interference by synthetic detergents with chemical coagulation. Since the negatively charged color colloids are intimately involved in the flocculation phenomenon from its first phase involving their neutralization by the positively charged trivalent aluminum ions and aluminum hydroxide colloidal particles, color removal was considered to be a good indicator of interference with normal coagulation.

Color determinations were made for the raw water and the supernatant from each jar test following filtration of the water through a sand filter to remove suspended material. Frequent backwashing of the filter prevented interference from floc penetration of the filter.

Alkalinity and pH determinations were made for the purpose of detecting possible errors in coagulant dosage and for measuring additional alkalinity contributed to the water by the synthetic detergent compounds.

Experimental Results

Synthetic Detergents—Retail Products

Of the 11 retail synthetic detergents studied, 6 of the anionic products and 1 nonionic (All) caused a marked interference with alum coagulation. One anionic product (Vel) had only a slight effect on coagulation. The remaining anionic product (Dreft) and the two liquid nonionics (Glim and Joy) had no effect on coagulation.

The effects of the 8 coagulation-interfering retail products on alum coagulation are shown graphically in Fig. 1. These curves illustrate the relationship between alum dosage and color removal attained at different

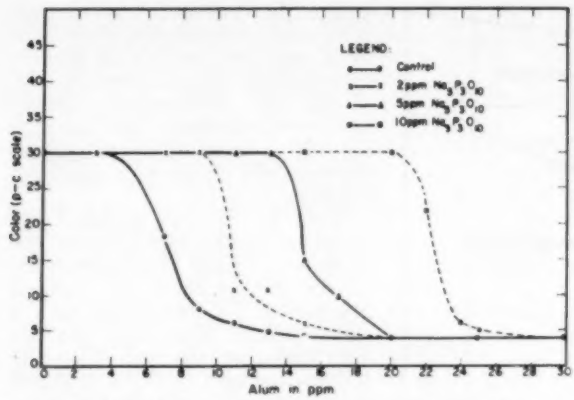


Fig. 3—Effect of sodium tripolyphosphate upon coagulation of water with alum

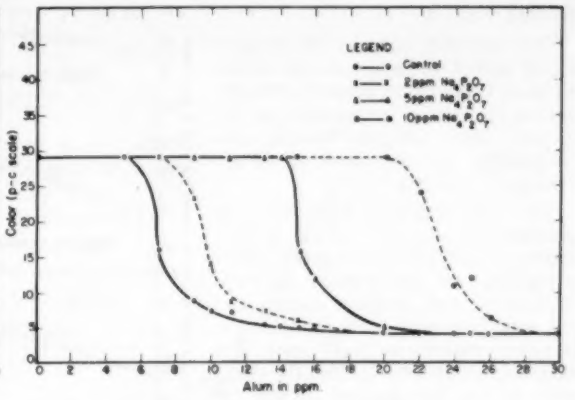


Fig. 4—Effect of tetrasodium pyrophosphate upon coagulation of water with alum

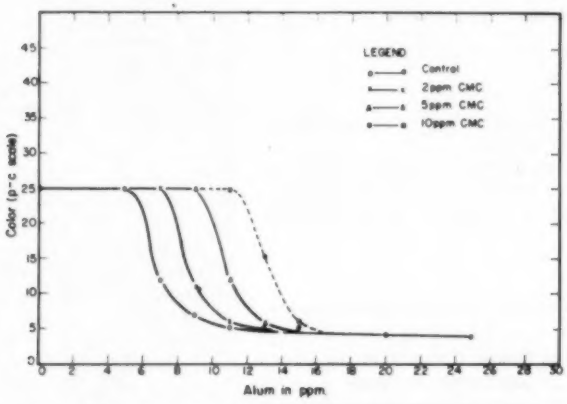


Fig. 5—Effect of sodium carboxymethylcellulose upon coagulation of water with alum

concentrations of each retail product. Although color removal was the primary means of measuring the effect on coagulation, it was supplemented by observation of floc formation and settling characteristics. In no instance was the settleability or character of the alum floc adversely affected by the compounds in solution. The degree of color removal was always proportional to the extent of floc development, as would be expected.

The nature of the interference with coagulation by the retail products appeared to be, essentially, that of increasing the coagulant requirements. Once flocculation took place, no difference could be detected between floc characteristics and behavior as observed for the control series and the three series containing varying concentrations of these compounds.

A quantitative evaluation of the effect on coagulation was made by plotting the alum dosage required to reduce the color content of the water to 10 color units against the concentration of the retail product in solution. The resulting curves are shown in Fig. 2. The linear relationships expressed by these curves disclosed that the alum dosage required to attain a reduction in the natural color content of the water to 10 color units can be expressed as a linear function of the concentration of interfering retail product in solution, as follows:

$$A = (f_i)(D) + A_o \quad \text{.....(1)}$$

in which

A = Alum dosage, in ppm, required to attain color reduction at varying concentrations of retail synthetic detergent product;

f_i = Slope of the linear function plotted on rectangular coordinate paper;

D = Concentration of retail synthetic detergent product, in ppm; and

A_o = Alum dosage, in ppm, required to attain color reduction with no retail synthetic detergent product present in solution.

The slope of this linear function (f_i) has been entitled the "interference factor" and has been used as a parameter to indicate the relative effect of the various retail synthetic detergent products on color removal by alum coagulation.

Table 4 lists the retail synthetic detergent products in order of their effect on alum coagulation of water.

Surface Active Agents

Because of their fundamental properties and physical behavior in water, the surface active agents have been held responsible for the adverse effect of synthetic detergents on the chemical coagulation of water. The nine surface active agents tested constitute the bulk of the present production of anionic and nonionic surface active agents. None of these compounds interfered with alum coagulation in concentrations up to 10 ppm.

TABLE 4
Effect of Retail Synthetic Detergent Products on Alum Coagulation of Water

Retail Synthetic Detergent Product	Interference Factor
Tide	1.35
Breeze	1.12
Oxydol	1.06
Cheer	1.06
Surf	0.97
FAB	0.78
All	0.70
Vel	T*
Dreft	No effect
Glim	No effect
Joy	No effect

* Threshold effect only.

Builders

The fact that none of the surface active agents had any adverse effect on alum coagulation pointed strongly toward the builder compounds as the primary cause for interference with coagulation by the retail synthetic detergent products.

The four building compounds in greatest use today are sodium sulfate, sodium tripolyphosphate, tetrasodium pyrophosphate, and sodium carboxymethylcellulose. Sodium sulfate did not interfere with alum coagulation in concentrations up to 10 ppm. The extent of color removal and the character of the floc formed showed no deviation from the control series.

Sodium carboxymethylcellulose caused moderate interference with alum coagulation, and interference by both complex phosphates was severe. The effects of these three builders on alum coagulation are shown graphically by Figs. 3, 4, and 5. These figures illustrate the relationship between alum dosage and color removal attained at each concentration of builder compound.

The settleability and character of the alum floc were not adversely affected by the builders and interference with coagulation took the same form as that caused by the retail synthetic detergents. After flocculation took place, the floc characteristics and behavior were the same as that observed for the control series. The effect of these materials was to increase greatly the amount of coagulant needed to accomplish the desired color removal.

A quantitative evaluation of the effects of the three interfering builders on coagulation was obtained by plotting the alum dosage required to reduce the color content of the water to 10 color units against the concentration of the builders in solution.

The resulting curves are shown in Fig. 6. The linear relationships expressed by these curves are the same as those found to exist for the retail synthetic detergent products. That is, the alum dosage required to attain a reduction in the natural color content of the water to 10 color units can be expressed as a linear function of the concentration of builder in solution. The slope of this function (f_1) is also designated the "interference factor" and has been used to indicate the relative effect of the builders on color removal by alum coagulation. This parameter has also been used to compare the respective effects of builders and retail synthetic detergents on chemical coagulation.

Table 5 lists the builder compounds in order of their effect on alum coagulation of water.

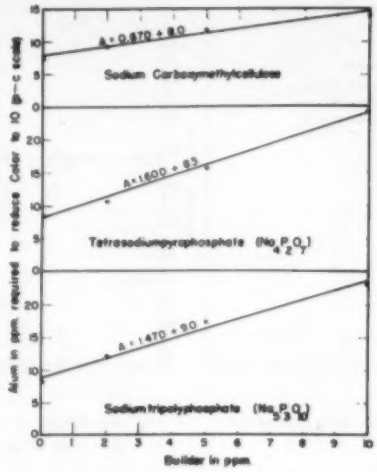

A = 0.870 + 9.0
Sodium Carboxymethylcellulose
A = 1600 + 93
Tetrasodiumpyrophosphate ($Na_4P_2O_7$)
A = 1470 + 90
Sodium tripolyphosphate ($Na_5P_3O_{10}$)
Alum in ppm. required to reduce Color # 10 @ pH = 6.8
Builder in ppm.

Fig. 6—Relationship of builder concentration to alum requirements

Sodium carboxymethylcellulose normally constitutes only about 2 per cent of a synthetic detergent by weight. Since this compound was used in the same concentrations as the synthetic detergents, its relative concentration was 50 times as great. In spite of this high concentration, sodium carboxymethylcellulose had less than one-half as much effect on coagulation as did the two complex phosphate builders.

Work by Sawyer[4] strongly suggested a relationship between the phosphorus content of a synthetic detergent and its effect on chemical coagulation. To demonstrate such a relationship, phosphorus analyses were made of the two phosphate builders and each synthetic detergent having any measurable effect on chemical coagulation with alum.

Phosphorus analyses were also made on Vel and Dreft to determine the threshold of interference level for phosphorus. Vel caused some slight interference at a color level above 10 color units; Dreft displayed no measurable effect on coagulation. The results of the phosphorus analyses of the synthetic detergents are given in Table 6.

To establish a relationship between the extent of interference with coagulation and the phosphorus content of the interfering compound, the interference factors were plotted on rectangular coordinate paper against the phosphorus content of each retail synthetic detergent product and complex phosphate builders. The resulting curve (Fig. 7) discloses that the degree of interference with coagulation, as determined by effect on color removal, can be expressed as a linear function of the amount of phosphorus in the interfering compound. This is shown as follows:

$$f_1 = 0.092P - 0.15 \quad \text{.....(2)}$$

in which

f_1 = Interference factor; and
P = Phosphorus content of synthetic detergent in per cent by weight.

The approximate threshold of interference with alum coagulation by retail synthetic detergent products in terms of their phosphorus content was found by assuming $f_1 = 0$ in Eq. 2 and solving for P. The resulting threshold level of 1.6 per cent phosphorus was substantiated by the coagulation studies, which disclosed no interference with coagulation by Dreft with a phosphorus content of 1.2 per cent and the onset of interference by Vel with a phosphorus content of 2.2 per cent.

TABLE 5
Effect of Builder Compounds on Alum Coagulation of Water

Builder Compound	Interference Factor
Tetrasodium pyrophosphate	1.60
Sodium tripolyphosphate	1.47
Sodium Carboxymethylcellulose	0.67
Sodium sulfate	No effect

TABLE 6
Phosphorous Content of Retail Synthetic Detergent Products

Retail Synthetic Detergent Product	Phosphorus Content, %
$Na_5P_3O_{10}$	23.3
$Na_4P_2O_7$	21.7
Tide	12.7
Breeze	13.7
Oxydol	12.8
Cheer	12.2
Surf	12.5
FAB	9.6
All	9.2
Vel	2.2
Dreft	1.2

Discussion

The inability of the surface active agents and the retail synthetic deter-

gent products of low or zero phosphorus content to adversely affect alum coagulation of colored water when present in concentrations up to 10 ppm is of considerable interest. The surface active agents in synthetic detergents have long been held responsible for coagulation and sedimentation difficulties in situations where such compounds have been found in the water.

The surface active agents studied in this work included all such compounds in greatest use today in the manufacture of domestic and industrial synthetic detergents. Their use in concentrations up to 10 ppm could reasonably be expected to interfere with chemical coagulation if the surface active agents have actually been responsible for coagulation difficulties experienced in water treatment plant operation. Since this was not the case, it is believed that the primary cause of interference with chemical coagulation by synthetic detergents must be associated with the builder compounds rather than with the surface active agents.

A large proportion of the water treatment plant operational problems pertaining to the chemical coagulation of water have occurred during the winter months when the temperature of the water was far below normal. During such periods of low water temperatures, the rate of hydrolysis of the complex phosphate builders in the stream to orthophosphates would be much slower than during periods of higher water temperatures.

The result would be higher complex phosphate concentration in the raw water during the winter months, with a resulting adverse effect on chemical coagulation. A good example of this might be the difficulties experienced at the Osawattomie, Kans., water treatment plant in the winter of 1953[11], when a severe interference with coagulation occurred with a surface active agent concentration in the water of 3.9 ppm. A year later, however, with the water temperature 20°F higher, no difficulties were experienced even though the surface active agent concentration reached 7.2 ppm[5].

The linear relationship found to exist between the extent of interference with coagulation and the phosphorus content of a synthetic detergent supports the belief that the complex phosphates are primarily responsible for the adverse effect of synthetic detergents on the chemical coagulation of water. Although there undoubtedly is some added effect from sodium carboxymethylcellulose, this is not considered significant because of the small quantity of this substance

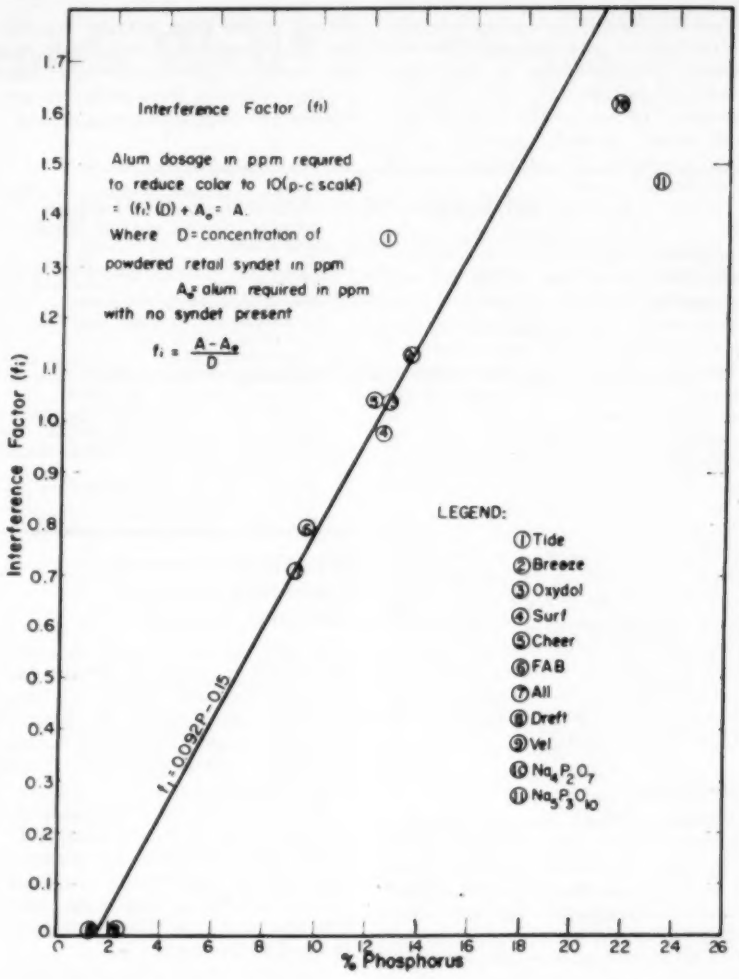


Fig. 7—Relationship of phosphorus content of synthetic detergents to alum requirements in color treatment

contained in synthetic detergents and its relatively low interference factor.

The particular property of the complex phosphates responsible for interference with chemical coagulation is not definitely known. Because their effect was quite clearly one of increasing the alum dosage level at which flocculation occurred, rather than altering the flocculation characteristics, it seems reasonable to believe that the complex phosphates have their greatest effect in their ability to precipitate and complex aluminum ions. Sodium carboxymethylcellulose is also a sequestering agent[12] and this may account for its effect on coagulation. The emulsifying and dispersing powers of the surface active agents did not adversely affect coagulation at concentrations up to 10 ppm.

The results of this investigation which pertain to the effect of surface active agents on alum coagulation are in substantial agreement with those obtained by Langelier and associates[8]. In their work, these compounds were used in concentrations varying from 17 ppm to about 20,000 ppm; in the work reported here the concentrations were limited to 10 ppm. It is not believed that adverse effects on chemical coagulation by surface active agents in concentrations exceeding 10 ppm would have any validity in reference to water treatment problems, because these materials are rarely, if ever, found in water supplies in greater concentrations.

Langelier and his co-workers used a synthetic turbid water prepared from a silty clay loam and measured interference with coagulation by the degree of turbidity removal obtained, as well as by observation of floc characteristics. These criteria are be-

lieved to give the same general results as the use of color removal. The important consideration is that they found no interference with alum coagulation by any of the three anionic and three nonionic surface active agents studied in concentrations of less than 17 ppm.

While Langelier and co-workers did not study the effects of any builder compounds on chemical coagulation, they did study the effects of two sequestering agents. These were sodium metaphosphate and sodium versenate. In the case of both compounds they found the alum dosage to increase linearly as the concentration of the metaphosphate or versenate was increased. This is the same effect as observed for the complex phosphates and sodium carboxymethylcellulose used in this series of studies, although the degree of interference was much greater with sodium metaphosphate than with sodium tripolyphosphate and tetrasodium pyrophosphate. This lends further emphasis to the importance of the complexing and sequestering action of complex phosphate builders as the primary cause of interference with chemical coagulation by synthetic detergents.

Conclusions

Retail synthetic detergent products vary greatly in their effect on chemical coagulation of natural water. Some increase the coagulant requirements considerably, whereas others show no effect.

The alum dosage required to attain a specified color removal in natural surface water varies linearly with the concentration of interfering retail synthetic detergent products in solution.

The surface active agents in greatest use today have no adverse effect on alum coagulation of water when present in concentrations up to 10 ppm, a level greater than that normally encountered in public water supplies.

Interference with alum coagulation of water by retail synthetic detergent products is caused by the complex phosphate builder compounds, with minor supplementary effect from sodium carboxymethylcellulose.

The degree of interference by retail synthetic detergent products with alum coagulation is a linear function of the amount of phosphorus in the product.

The particular property of the complex phosphates responsible for interference with alum coagulation is not definitely known. Because their effect was one of increasing the alum dosage level at which flocculation occurred, rather than altering flocculation characteristics, it is believed that the complex phosphates have their greatest effect in their ability to precipitate and complex aluminum ions.

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Third Gordon Research Conference on Stream Sanitation Scheduled

Announcement of the third Gordon Research Conference on Stream Sanitation, to be held at Kimball Union Academy, Meriden, N. H., June 18-22, has been made by Clair N. Sawyer, Chairman, and Leslie A. Chambers, Vice-Chairman.

The theme of the 1956 Conference will be "Bases of Water Quality Criteria." Major subjects for consideration will be requirements for human use, aquatic life, agriculture, industrial uses, and integration under conditions of multiple use.

The Conference will consist of five morning and four evening sessions with afternoons free for informal discussions. Registration will be limited to 100 people (capacity of dormitories) and must be made in advance of April 1. Information and application blanks are available from Dr. W. George Parks, Director, Gordon Research Conferences, University of Rhode Island, Kingston, R. I.

"Fine fellow, this foreman: we got together on a little deal. Sold him, too, on having the best-dressed crew ever to build a sewage treatment plant."

Horton Appointed Assistant Director of ORSANCO

Announcement has been made that Robert K. Horton has been appointed Assistant Director of the Ohio River Valley Water Sanitation Commission. The appointment was effective January 1, 1956. Previously he had been a Sanitary Engineer with the Commission, with major responsibilities in the investigation of pollution conditions on the Ohio and Wabash rivers and establishment of sewage and industrial waste treatment requirements.

Mr. Horton joined the Commission staff in 1949 following six years of activity as a U. S. Army Sanitary Corps officer in Peru and San Salvador, assigned to the Office of the Coordinator of Inter-American Affairs. In this capacity he directed installation of several sanitary engineering projects and served as advisor to national governments in sanitation matters. In San Salvador he also acted as chief of the United States unit with the rank of lieutenant colonel.

Prior to World War II he was engaged as a research engineer with the Textile Foundation in the development of waste treatment processes. He holds a bachelor's degree in civil engineering and a master's degree in sanitary engineering, both from the University of North Carolina.

It almost always pays to do a little better than seems necessary.

Where *Is* Joseph's Well?

by JAMES M. SYMONS and GEORGE E. SYMONS

James M. Symons is a graduate student in Sanitary Engineering at Massachusetts Institute of Technology; Dr. Symons is a Consultant and Technical Editor, Larchmont, N. Y. In this article, the authors set the records straight on the location of ancient wells.

IN ONE of the series of articles on Water Works Practices currently running in this magazine, the junior author of this article, in reviewing the history of water supply, referred to Joseph's Well. A letter from a reader pointed out that the well referred to was in reality Jacob's Well.

A search of the Bible indicated that Jacob's Well was on the ground given to Joseph and therefore the well may have been called by both names. A second reader pointed out that the Joseph's Well generally mentioned in water works literature was in Egypt, not in Palestine, and that it was not mentioned in the Bible.

To clear up any misunderstanding and misleading comments published heretofore, the authors undertook some study in the Engineering Societies Library in New York City and in the Harvard University Library in Cambridge, Mass.

Two Wells

First, let it be understood that there are two wells, both constructed in antiquity. Both are still in existence, and both are marvels of engineering for their size and complexity. One, Jacob's Well, in Palestine, has a well-documented history. The other, Joseph's Well, in Cairo, Egypt, is shrouded in mystery.

It is natural that some confusion would arise as to which Joseph actually dug Joseph's Well. The popular Bible story telling of the sale of Jacob's son Joseph to the Ishmaelites and his subsequent rise to power in Egypt forms a natural link between the biblical Joseph and Joseph's Well. Although this period of civilization is not well documented, such references as exist do not seem to bear out this connection.

It appears doubtful, too, that Jacob's Well in Palestine was also called Joseph's Well, although, as the son of Jacob, Joseph inherited the land on which that well was dug. In an attempt to set the records straight, a more complete background on the construction of Jacob's Well, as well as some data concerning Joseph's Well, seems pertinent. In addition, some details of the wells themselves are presented here.

Jacob's Well

From the Book of Genesis in the Bible, and from "Joseph and His Brothers," by Thomas Mann, comes the story of Jacob's family. The accompanying chart shows the family tree.

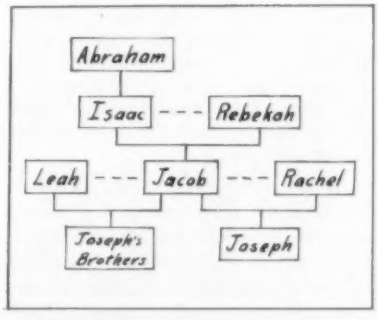
The first mention of wells in connection with Jacob's family was that Isaac, son of Abraham and father of Jacob, lived by a well in Lahairoi. It was here that Jacob was born to Isaac and Rebekah.

Shortly after Jacob's birth, a famine forced the family to move to Gerar (see map), where Isaac occupied himself with "redigging the wells of his father, Abraham." That job completed, Isaac moved his family to Beer-Sheba, where his servants dug a well, named Sheba.

To make his own way in life, Jacob left Beer-Sheba to visit his uncle Laban, who lived at Horan, about 350 miles across the desert (Lat 37°N, Long 39°W). It required 17 days for Jacob to make the trip, but he stayed for 25 years.

On the day of his arrival at Horan, Jacob met Laban's 12-year-old daughter, Rachel, standing by a well and it was with her that he fell in love. Laban promised Rachel's hand to Jacob, if he would work for seven years. Jacob agreed and set to work.

Lack of water was a severe problem to Laban, and apparently the digging of wells was an important part of the hired hand's work. One day, during a severe drought, while digging in Laban's cornfield, Jacob discovered "with the Lord's help," a subterranean spring which gushed to the height of an "ell" or three spans (about 18 to 24 inches). This water was a welcome sight to Laban, who used it for irrigation.

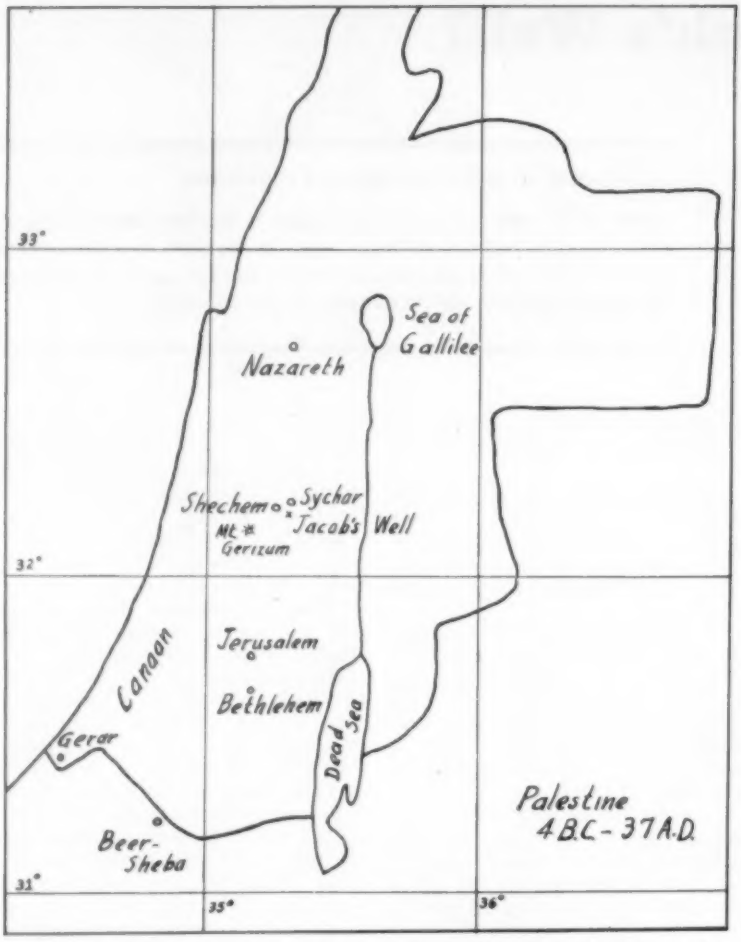


JACOB'S family tree

When his indenture to Laban was finished, Jacob was allowed to marry Rachel, now nineteen years old. Laban, however, substituted his eldest daughter, Leah, for Rachel during the marriage ceremony. When Jacob discovered the mistake the next morning, Laban allowed him to be married to both girls at the same time. Rachel was barren, but Leah bore him many sons. After 12 years of marriage, Rachel, now thirty-one, bore Jacob a son, Joseph. When Joseph was six years old, Jacob took his family back to Canaan, the land of his father, the southwest section of Palestine. Rachel died while enroute.

During the long trip Jacob stopped outside Shechem where he dug the well that bears his name. From the Bible (John 4:5), we learn that this well is in Sychar, but the map shows Sychar and Sechem to be very close together. Modern maps locate this well 1.5 miles southeast of Nablus, the ancient Shechem. It is close to the highway from Jerusalem to Gallilee on the plain of Moreh, at the east base of Mt. Gerizum. Joseph's tomb is very close to this spot, on the land passed on to him from his father, as related in John 4:5.

The one specific mention of Jacob's Well in the Bible is: John, 4:4-12—"Then cometh he (Jesus) to a city of Samaria, which is called Sychar, near the parcel of ground that Jacob gave to his son Joseph. Now Jacob's well was there. Jesus being wearied with his journey, sat thus on the well: and it was about the sixth hour. There cometh, a woman of Samaria to draw water: Jesus saith unto her, 'Give me a drink'. Then saith the woman of Samaria unto him, 'How is it that



MAP of Palestine—4 B.C. to 37 A.D. (From "Historical Atlas of the Holy Land," Plate 19, by Sir George Adam Smith)

thou, being a Jew, askest drink of me which am a woman of Samaria?' for the Jews have no dealings with the Samaritans. Jesus answered and saith unto her, 'If thou knewest the gift of God and who it is that saith to thee, Give me a drink; thou wouldest have asked of him, and he would have given thee living water'. The woman saith unto him, 'Sir, thou hast nothing to draw with, and the well is deep: from whence then hast thou that living water. Art thou greater than our father Jacob, which gave us this well, and drank thereof himself, and his children, and his cattle?' "

E. L. Waterman, in "Elements of Water Supply Engineering," describes Jacob's Well as 105 feet deep, 9 feet in diameter, with water 90 feet down. It is now owned by the Greek Church of Nablus. The Bible Concordance adds, that, "although the well was once of great depth", it has since been filled with rubbish and today it is only 75 feet deep.

When Jacob and his family moved on toward Canaan, Joseph did not accompany them. Here the famous story of the coat of many colors took place, Joseph eventually being sold by his brothers to the Ishmaelites, who carried him to Egypt, where he became very powerful. In Egypt Joseph had his dream of seven fat and seven lean cows, and interpreted the dream to mean there would be seven years of plenty followed by seven years of famine. In accordance with this prophesy, Joseph inaugurated a program of conservation and storage. At this point the error is usually made linking Joseph with the construction of Joseph's Well.

As a further biblical link between Joseph and the well in Cairo, one may refer to the description by his dying father Jacob when visiting Joseph in Egypt: "Joseph is a fruitful bough, even a fruitful bough by a well; whose branches run over the wall."

Joseph's Well

The connection previously mentioned might seem to be a valid one, but chronology does not bear it out. The Pharaoh with whom Joseph was associated was probably Amenophis III or IV, roughly 1500 B.C. At this time the capital of Egypt and the center of commerce was Thebes. The area now occupied by Cairo was an open plain until about 400 A.D., when the Arabs began building what is now the present city.

If this is the case, the question arises: "Who did construct Joseph's Well?" In a book published in 1845 and titled "A Description and Historical Account of Hydraulics and Other Machines for Raising Water," the author, Thomas Eubank, comments as follows: "Opinions respecting the date of this well are exceedingly various. Pococke thought it was built by a vizier named Joseph, eight hundred years ago (about 1000 A.D.); other authorities more generally attribute it to Saladin, the intrepid defender of his country against the hordes of European savages, who under the name of crusaders spread rapine and carnage through his land. His name was Yussef (Joseph). By the common people of Egypt, it (the well) has long been ascribed to the patriarch of that name, and their traditions are often well founded . . ."

According to the second theory mentioned, the well in Cairo was dug by (or for) the first Ayyubite Sultan of Egypt, Saladin (Yussef or Joseph), who lived from 1138 to 1193 A.D. For a fact, it was he who, in 1177, built the citadel in which Joseph's Well is located.

Eubank's book also contains a complete description of the well located in Cairo, and a diagram of the construction. A reproduction of that diagram is shown herewith. While Eubank's writing style and punctuation of 110 years ago are not particularly easy to read, the content is so interesting that it bears quoting completely. Eubank wrote:

"The most remarkable well ever made by man is Joseph's Well at Cairo. Its magnitude and the skill displayed in its construction, which is perfectly unique, have never been surpassed. This stupendous well is an oblong square, twenty-four feet by eighteen; being sufficiently capacious to admit within its mouth a moderate sized house. It is excavated (of these dimensions) through solid rock to the depth of one hundred and sixty-five feet, where it is enlarged into a capacious chamber, in the bottom of which is formed a basin or reservoir,

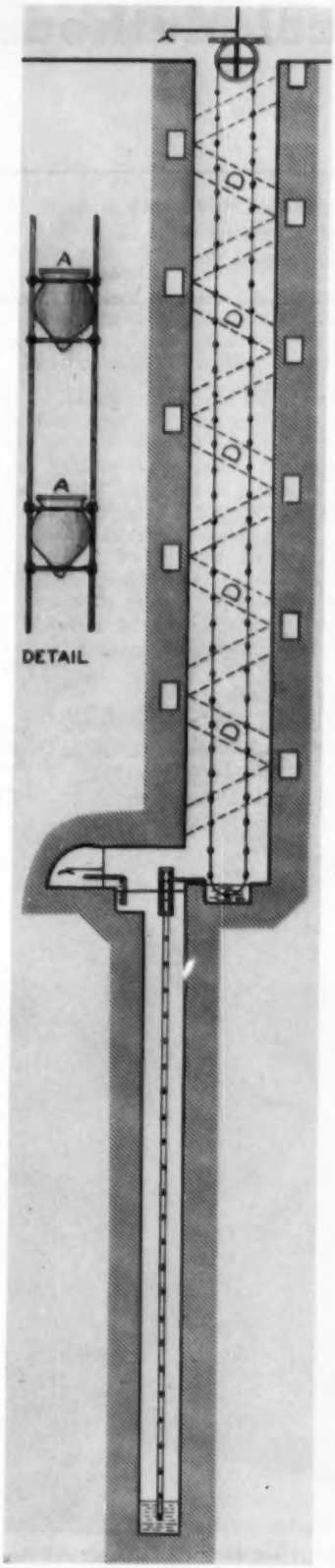
to receive the water raised from below (for this chamber is not the bottom of the well). On one side of the reservoir, another shaft is continued, one hundred and thirty feet lower, where it emerges through the rock into a bed of gravel where the water is found. The whole depth being two hundred and ninety-seven feet. The lower shaft is not in the same vertical line with the upper one, nor is it so large, being fifteen feet by nine. As the water is first raised into the basin, by means of machinery propelled by horses or oxen *within the chamber,* it may be asked, how are these animals conveyed to that depth in the tremendous pit, and by what means do they ascend? It is the solution of this problem that renders Joseph's Well so peculiarly interesting, and which indicates the advanced state of the arts, at the period of its construction.

"A spiral passage-way is cut through the rock, from the surface of the ground into the chamber, independent of the well, around which it winds with so gentle a descent, that persons sometimes ride up or down upon asses or mules. It is six feet four inches wide, and seven feet two inches high. Between it and the interior of the well, a wall of rock is left, to prevent persons falling into, or even looking down it (which in some cases would be equally fatal), except through certain openings or windows, by means of which, it is faintly lighted from the interior of the well: by this passage the animals descend, which drive the machinery that raises the water from the lower shaft into the reservoir or basin, from which it is again elevated by similar machinery, and other oxen on the surface of the ground. See figure. In the lower shaft, a passage is also cut down to the water, but as no partition is left between it and the well, it is extremely perilous for strangers to descend.

"The square openings represented on each side of the upper shaft [in the figure], are sections of the spiral passage, and the zigzag lines indicate its direction. The wheels at the top carry endless ropes, the lower parts of which reach down into the water; to these, earthenware vases are secured by ligatures, see AA, at equal distances through the whole of their length, so that when the machinery is moved, these vessels ascend full of water on one side of the wheels, discharge it into troughs as they pass over them and descend in an inverted position on the other. . . .

"This celebrated production of former times, it will be perceived, resembles an enormous hollow screw, the center of which forms the well, and the threads, a winding staircase around it. To erect of granite a flight of "geometrical" or "well stairs" two or three hundred feet high, on the surface of the ground, would require extraordinary skill; although in the execution, every aid from rules, measures, and the light of day would guide the workman at every step; but to begin such a work at the top, and construct it downwards by excavation alone, in the dark bowels of the earth, is a more arduous undertaking, especially as deviations from the correct lines could not be remedied; yet in Joseph's Well, the partition of rock between the pit and the passage-way, and the uniform inclination of the latter, seem to have been ascertained with equal precision, as if the whole had been constructed of cut stone on the surface. Was the pit, or the passage, formed first; or were they simultaneously carried on, and the excavated masses from both borne up the latter?

"The extreme thinness of the partition wall, excited the astonishment of M. Jomar, whose account of the well is inserted in the second volume of Memoirs in Napoleon's great work on Egypt, part 2nd, p. 691. It is, according to him, but sixteen centimetres thick (about six inches). He justly remarks that it must have required singular care to leave and preserve so small a portion while excavating the rock from both sides of it. It would seem no stronger in proportion, than sheets of pasteboard placed on edge, to support one edge of a modern built house, for it should be borne in mind, that the massive roof of the spiral passage next to the well, has nothing but this film of rock to support it, or to prevent such portions from falling, as are loosened by fissures, or such as, from changes in direction of the strata are not firmly united to the general mass. But this is not all: thin and insufficient as it may seem, the bold designer has pierced it through its whole extent with semicircular openings, to admit light from the well: those on one side are shown in the figure."



SECTION of Joseph's Well, Cairo, Egypt

These two wells, one in Cairo, Egypt, and one near Nablus, Israel, both designed with great care and dug with great effort, are monuments, not only to the engineering genius of the ancients, but to the importance of water supply down through the ages.

Now that we know where Joseph's Well is located, it is interesting to speculate as to who really dug it and how was it done. This subject would make an excellent thesis topic for some student historian interested in engineering.

Practical Methods for Attaining

by FRANK H. RUMBLE
Allis-Chalmers Mfg. Co.
Milwaukee, Wis.

ANYONE at all familiar with the modern multiple V-belt drive is aware that a V-belt derives its grip from the wedging contact between the sides of the V-shaped belt and the sides of the V-shaped grooves of the sheaves. Because of this wedging contact, a V-belt requires less tension than a round or flat belt, which depends for its grip solely on frictional contact with the sheave surface.

This very fact sometimes causes trouble. Because of the effectiveness of their grip and the generally accepted fact that they do require less tension than other types, there is often a tendency to apply too little tension on V-belts. Experience shows that there are a great many more V-belt drives operating with insufficient tension than there are drives with too much tension. Drives with slack, sagging belts almost always need more tension. Proper adjustment will often remove the sag and cause the belts to operate more uniformly and efficiently.

Even though the V-belt drive requires less tension than other types, to operate correctly and assure longest life of both belts and sheaves a V-belt drive must have some tension on the belts. Otherwise, the belts will slip while in use, quickly wearing both belts and sheave grooves. Also, slack belts have a tendency to "whip," jerk, and not operate in unison.

The question is, naturally, what is the correct amount of tension for V-belts and what is a practical means of attaining it? Before attempting to answer these questions, it would be well to examine a few other facts.

Initial Stretch

Like a pair of new shoes, V-belts when first installed need a "breaking-in" period. Over the period of their useful working life standard V-belts of rubber, cord and fabric will show a total stretch of approximately 4 per cent.

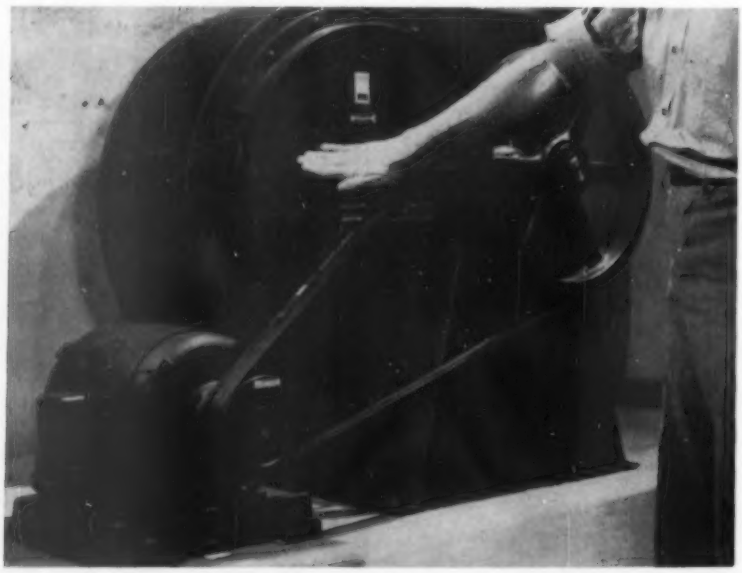


Fig. 1—V-BELTS under proper tension feel springy and alive when slapped with the palm of the hand; slack belts feel dead

The stretch is effected gradually and may only become apparent after the belts have been under proper tension for a relatively long period. However, a small amount of this stretch occurs soon after belts have been installed and until they reach their working length. After this initial stretch is removed the belts resist further "give" and retain a large share of their elasticity.

It is possible, of course, to put so much tension on a V-belt drive that the belts themselves will be "tight as fiddle strings;" the belts will be unduly stretched and the bearings of motor and driven machine overloaded and damaged. However, this danger is not too great and is not frequently encountered unless excessive tension is applied deliberately and without reason.

All that is necessary on the average properly engineered drive is to apply enough tension to prevent slipping of the belts under full load. Slippage can readily be detected by use of a tachometer applied to driver and driven sheaves. If an excessive amount of tension is required to keep the belts from slipping, the engineering of the drive should be checked. Perhaps the drive should have larger diameter sheaves or more belts. Use of high-capacity type belts may offer a solution.

The phenomenon of belt sag is well known, but the facts in connection with it are often misinterpreted. Sometimes on a matched set of belts which has been in use, and frequently with newly installed matched belts, some belts will sag more than others and appear to be considerably longer. Actually, this is not the case. In the modern method of matching V-belts the maximum difference in length between longest and shortest belts in the set is only 0.1 inch per 100 inches of belt length, or 0.1 per cent.

The amount of sag this may produce is deceiving. On a center distance of 100 inches on drives with both shafts parallel to the floor or base, a sag of 2 inches in a belt will appear drastic, yet it can be removed by only 0.054 inch of take-up on the motor base—less than 1/16 in.

Stretching the shorter belts in the set this small amount to bring them up equal with the others will not harm them. In fact, considerably more than this amount of stretch must be ap-

Proper Multiple V-Belt Tension

plied to all of the belts in the set.

Research has shown that V-belts operate best when under slight stretch, which is, of course, induced by putting them under tension. That is the reason the belts are made resilient and elastic — a necessary attribute of V-belts working in multiple. Belts under proper tension are operating under approximately 0.5 per cent stretch.

Measuring Proper Tension

It is impractical in the average shop or factory to actually measure the pounds of tension which are applied on a V-belt drive, such as can be done in the laboratory with special equipment. Exact measurement is not necessary, however; it is sufficient to have practical ways of approximating the correct tension.

The experienced operator can tell by observation and feel whether or not a set of V-belts is under proper tension. Unless the drive has an unusually long center distance, the belts under proper tension have little, if any, sag. A slack V-belt feels dead when thumped with the hand; a properly taut belt (Fig. 1) has an alive springiness.

There are other ways of judging whether or not a V-belt drive has the proper tension. One way is by use of a tachometer, as previously mentioned. After a set of belts has been installed, all the slack removed, and the drive started up, the rpm of the driver shaft can be checked with the rpm of the driven shaft according to speed ratio. Tension should be applied only to the point where no slippage is evident. The procedure should be repeated every few days until the belts are broken in and set properly.

Another method, favored by some operators, is that of depressing the belts as shown in Fig. 2. With the drive stopped, press down firmly on each individual belt. A belt which can be depressed an amount equal to its own thickness for each 48 inches of unsupported length is properly tensioned. This allows for the fact that the larger the cross-section, the greater the amount of tension required. Where 48 inches of unsupported length is not available, a proportional amount of pressure should be exerted.

Still another way of quickly attaining the approximate correct tension when installing a set of belts is to proceed as follows: After the belts are fitted in the grooves properly, move the motor away from the driven machine just to the point where belt sag is eliminated. Indicate the exact center distance by making a chalk or pencil mark on the motor base. Then make an additional take-up of ½ inch for each 100 inches of center distance (Fig. 3). Proportionate take-up should be made on longer or shorter center distances.

This will approximate about 0.5 per cent stretch and put the belts under the proper tension. They should be checked after the first few days use with the "hand thumping" or "depressing" method to be sure they have not loosened up. If so, more take-up will be required.

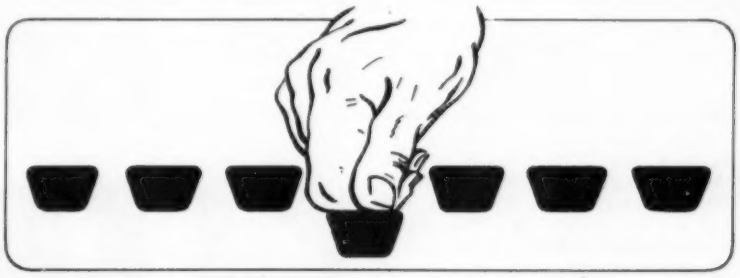


Fig. 2—ANOTHER METHOD of checking tension is to depress belts one at a time. A belt under proper tension can be depressed, with reasonable pressure, an amount equal to its own thickness for each 48 inches of unsupported length

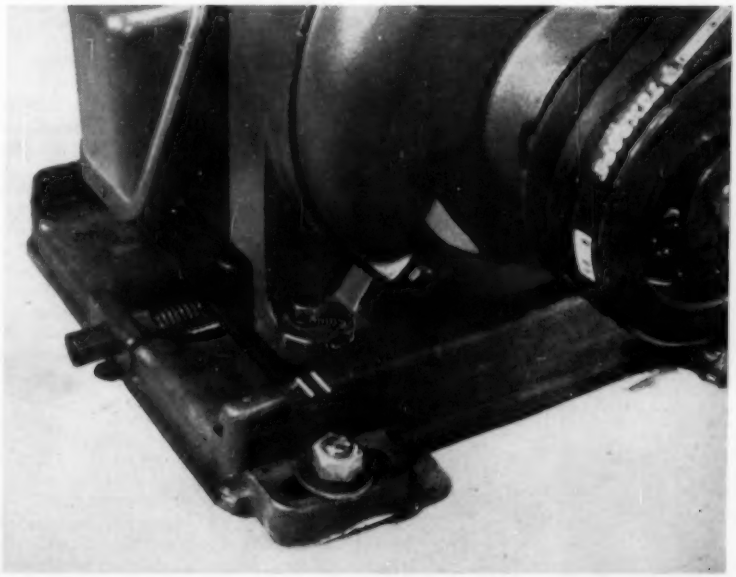


Fig. 3—PRACTICAL way to obtain 0.5 per cent stretch needed for proper tension is to fit belts in grooves properly, move motor away from driven machine until all slack and undue sag is removed, make chalk mark on base at end of movable plate, then make additional take-up in ratio of ½ inch for each 100 inches of center distance

Paul Weir

A. W. W. A. Board Actions

Weir for president; Merryfield for vice-president
Orchard voted Achievement Award; Gordon Diven Medalist
Honorary Memberships to Black, Cronin, Skinker, Weir

Fred Merryfield

MEETING in New York City Jan. 15-17, the Section Directors of the Am. Water Works Ass'n. chose those listed herein as nominees for the offices named. Such selection is tantamount to automatic election and assumption of offices at the close of the 1956 Annual Convention in St. Louis, Mo., May 6-11 next.

FOR PRESIDENT:
Paul Weir, Genl. Manager,
Atlanta Water Works, Atlanta, Ga.

FOR VICE-PRESIDENT:
Fred Merryfield, Prof. San. Eng.,
Oregon State College, Corvallis, Ore.

FOR TREASURER:
W. W. Brush, Editor,
"Water Works Engineering," N. Y. City

Honorary Memberships Bestowed

Elected to Honorary Membership were the following:

A. P. BLACK, Head, Dept. of Chemistry, Univ. of Florida, Gainesville, Fla.—a past president of A.W.W.A.; Diven Medalist; Goodell Prize Winner and Fuller Awardee.

H. F. CRONIN, Chief Engr., Metropolitan Water Board, London, England—member of A.W.W.A. since 1944.

THOS. J. SKINKER, Commissioner of Water, St. Louis, Mo.—Life Member, past Director and Fuller Awardee.

W. VICTOR WEIR, President, St. Louis County Water Co., University City, Mo.—a past-president of A.W.W.A.; Diven Medalist; Goodell Prize Winner; Fuller Awardee.

Awards, Medals and Prizes

The Harry E. Jordan Achievement Award was established by the A.W.W.A. Board in 1951 "to be voted to an outstanding member of the Association who has rendered distinguished public service outside the line of duty." To date this award has been made only once before—to Abel Wolman in 1951 in recognition of services to the new state of Israel and other civic services.

This year the Harry E. Jordan Achievement Award is being conferred on WILLIAM J. ORCHARD of Maplewood, N. J., Honorary Member since 1937, Diven Medalist in 1953 and longtime Director and Moderator in A.W.W.A. The citation reads "For his lifetime of devotion to the better interest of his State and Community, always giving life and leadership to enterprises in the public interest." For a number of years "Bill"

W. J. Orchard
(Achievement Award)

Fred G. Gordon
(Diven Medal)

Orchard has continued to serve A.W.W.A. as member of its General Policy Committee and as chairman of the Finance Committee.

The John M. Diven Memorial Medal, awarded for an outstanding service to the Association, was voted to FRED G. GORDON, Asst. Chief Engr., Dept. of Public Works, Chicago, for his constructive committee leadership in producing Standard Specifications for Metal-Seated and Rubber-Seated Butterfly Valves under his chairmanship.

The John M. Goodell Prize, for the outstanding paper of the year printed in the A.W.W.A. Journal, was voted to the authors of the paper "Design of Wye Branches for Steel Pipe." The authors are H. S. SWANSON, H. J. COMPTON, W. J. WILKINSON, C. L. KING and E. D. NELSON of the Los Angeles Dept. of Water and Power.

The Harry E. Jordan Scholarship Award, established by the Water and Sewage Works Mfgrs. Assn., in recognition of services rendered by Secretary Jordan, was voted to MARVIN R. LINDORF, of Oakland, Calif., a senior sanitary engineering student at the Univ. of California, where he now will pursue graduate studies.

Division Award Papers

The author of a published paper, considered of greatest value to the particular division before which it was presented, is voted an award of commendation. The following were so honored.

TO: LESLIE PAUL of Oakland, Calif., the Distribution Div. Award for his paper "Selection of Valves for Water Works Service" published in the Nov. 1954 Journal.

TO: ABEL WOLMAN of Baltimore, Md., the Management Div. Award for his paper "Providing Reasonable Water Service" published in the January 1955 Journal.

TO: ARNOLD K. CHERRY of Cedar Rapids, Ia., the Purification Div. Award for his paper "Split Treatment Method of Softening Water" published in the April 1955 Journal.

TO: F. B. LAVERTY of Los Angeles, Calif., the Resources Div. Award for his paper "Development of a Fresh Water Barrier for Prevention of Sea Water Intrusion" published in the September 1955 Journal.

Section Competition Awards

It took no little doing on the part of the large and growing SOUTHWEST SECTION to win the Hill Cup for showing the best gain in membership for 1955. (Runners up were the Indiana and California Sections.)

The CUBAN SECTION was winner of the Henshaw Cup for having present at its 1955 meeting the highest ratio of Association members to non-members. (Runners up were the Montana and Pacific N.W. Sections.)

The CALIFORNIA SECTION, as for years, continues possessor of the "Old Oaken Bucket," symbol of A.W.W.A.'s largest section. (With but a 272 member lead over the hustling Southwest Section, the boys of the "Lone Prairie" country are giving notice to the guardians of the Old Bucket that "it won't be long now!")

A. P. Black
(Hon. Member)

H. F. Cronin
(Hon. Member)

Thos. J. Skinker
(Hon. Member)

W. Victor Weir
(Hon. Member)

SEWAGE WORKS PRACTICES

Primary Sedimentation

Series 2—Part 5

by DON E. BLOODGOOD

Mr. Bloodgood is Professor of Sanitary Engineering, Purdue Univ., Lafayette, Ind. In this series, he discusses *Sewage Works Practices* in the form of short course lectures. These are designed to assist plant operators, students, and all who wish to review fundamentals in this field.

OPERATION of primary sedimentation tanks is an important part of the operation of any sewage treatment plant. Therefore, it should be seriously supervised in order to obtain the best removals possible.

It is necessary to understand some of the principles of sedimentation so that operation procedures are always such that they do not interfere with the natural tendencies of sediment. The biological and chemical processes are affected by certain laws of bacteriology and chemistry; sedimentation is influenced by the laws of physics. In the biological and chemical processes there are ways of changing environment so that there are modifications of the degree of effectiveness and the rate of accomplishment. In treatment of sewage by sedimentation there are not feasible ways of modifying the process to improve it.

Factors Influencing Sedimentation

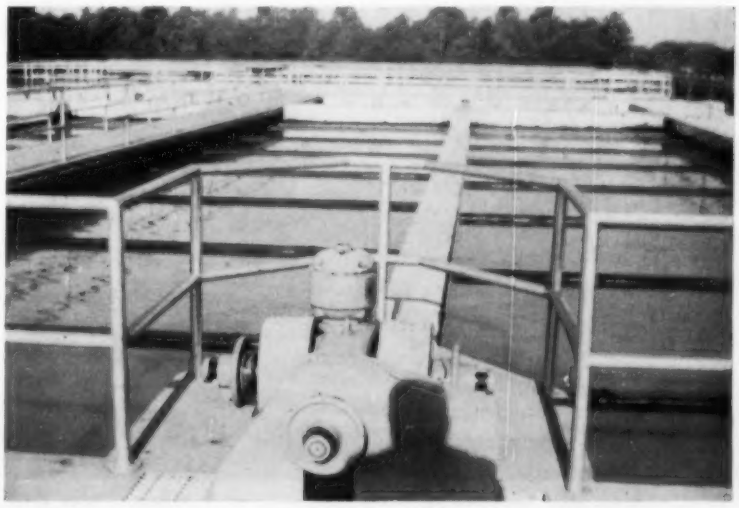
The basic factors that influence the rate of sedimentation are (a) the size of the particle, (b) the specific gravity of the particle, and (c) the viscosity of the liquid. The larger the particle the faster it will settle in a liquid, providing it has a specific gravity greater than one. The greater the specific gravity the faster a particle will settle. The viscosity of the liquid has an effect on the rate of particles settling in it.

If larger particles settle faster, it would be advantageous to bring small particles together to form larger masses. This is sometimes done prior to settling by agitation with air or by mechanical stirring to bring the small particles in contact with each other. Some solid particles cling to each other once they make contact. The coagulation of particles is not accomplished in primary settling tanks. Severe agitation, such as turbulence caused by pumping, could be detrimental in settling because some of the solids might be broken into smaller pieces.

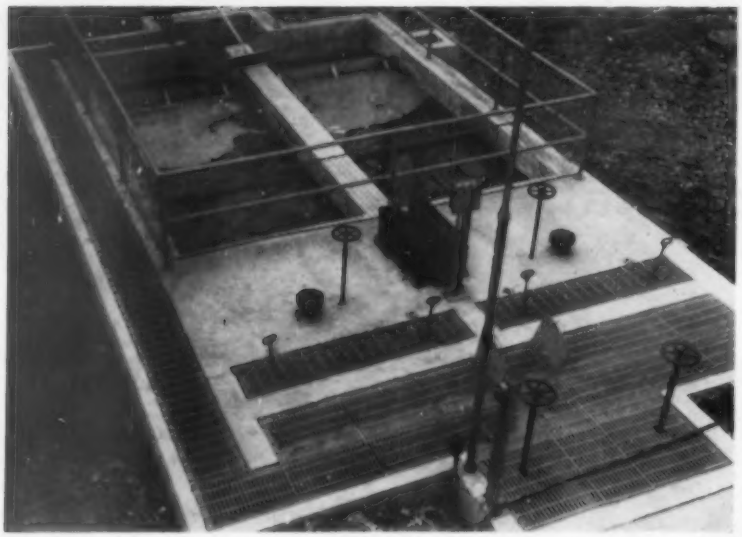
Specific gravity is the ratio obtained by dividing the weight of substance by the weight of an equal volume of water. The higher the specific gravity the more easily will the material settle when placed in water. Some substances that have a very low specific gravity may float when first placed in water, but after they have absorbed water they become nearly the same weight as water and may, after suspension in water for a long time, have a tendency to settle when left in a quiescent state for a period of time.

The specific gravity of primary sludge has been determined and it is reported to be just a little greater than one. This indicates that many of the solids in primary sludge when wet have a weight not much greater than water. Some of the solids, like grit, have a specific gravity of about 2.5. Attempts have been made to add powdered high specific gravity materials to sewage in the hope that the heavier particles would become attached to the lighter ones, weighting them sufficiently so that they would settle in a reasonable period of time.

The suspended solids in sewage do not all settle out in a reasonable period of time. In fact, only about 62 per cent can be removed by sedimentation. This means that the particles are so



PRIMARY SETTLING tanks with drive for sludge collector and skimming mechanism at inlet end (foreground)



TWIN primary tanks at Indiana State Soldiers Home are partially decked for accommodation of operating controls and machinery, as well as to help relieve surface disturbances due to wind. Tank by-pass is under grating at left

small that they do not move through the water or that their specific gravity is very close to one.

The viscosity of the liquid in which solids are suspended has a definite bearing on the rate of solids settling. Some liquids, such as syrup, are very viscous and materials move through them with great difficulty. The viscosity of many liquids can be decreased by heating them. The water in sewage behaves the same way, although the change in viscosity is not very great in the ranges of temperature usually experienced.

This natural change in viscosity between winter and summer would be such as to make it seem that the lower viscosity water would be experienced in the summer and that consequently, solids in sewage should settle more readily in the warmer weather than they do when it is cold. The effect on per cent removals due to viscosity changes is not apparent in data collected at sewage plants.

These several factors influence the rate of settling. The resistance of particles to settle was first expressed as a "law for drag" by Sir Isaac Newton. The law has been expressed in various ways, but the one that expresses the velocity of settling of spheres will suffice to show the relationship of the several factors. In the Stokes Law equation

$$v = \frac{1}{18} \frac{g}{\mu} (p_s - p) D^2 \quad \text{.....(1)}$$

in which

v = the velocity of settling;
g = the gravity constant;
μ = the kinematic viscosity;
p = the mass density of the fluid;
p_s = the mass density of the spheres;
$\frac{p_s}{p}$ = specific gravity; and
D = the diameter of the spheres.

Besides the natural laws that govern the settling of solids in liquids there are many other factors that have a bearing on the degree of removal obtained in a settling tank.

One of the most important of these last-mentioned factors is that of rate of flow through the settling tank. Hazen[1] in 1904 developed a theory for per cent removal in an "ideal settling tank." He expressed this theory in an equation showing the factors that he believed to be important. The formula is:

$$\text{Per cent removal} = \frac{a}{t} = \frac{V_s}{Q/A_H} \quad \text{.....(2)}$$

in which

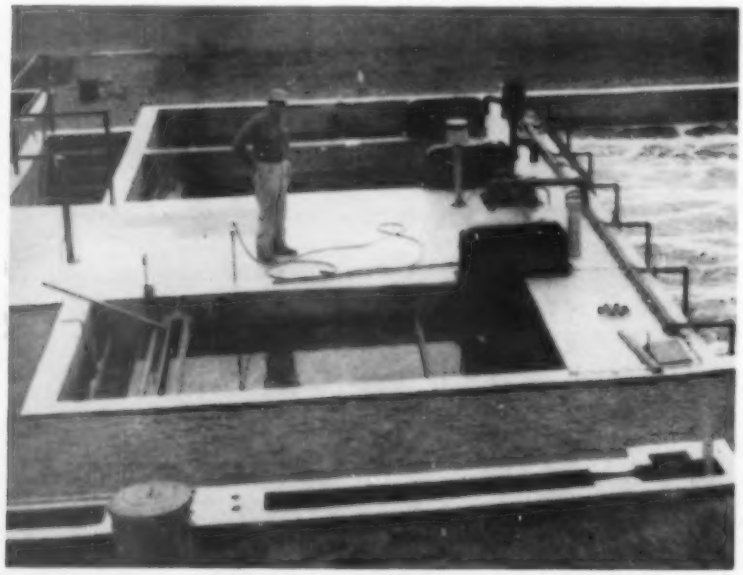
a = detention time;
t = time for particle to descend through a depth, D;
V_s = settling velocity;
Q = discharge; and
A_H = surface area of the tank.

The equation does not have an expression for the depth of the tank. Therefore, if the relationships are taken to be valid for an ideal tank the depth of a settling tank must not be of importance. According to the theory, a settling tank could be infinitely shallow. It seems unlikely that any such unrealistic tank will ever be constructed. Control agencies have not as yet allowed settling tanks to be constructed that were not at least 7 feet deep.

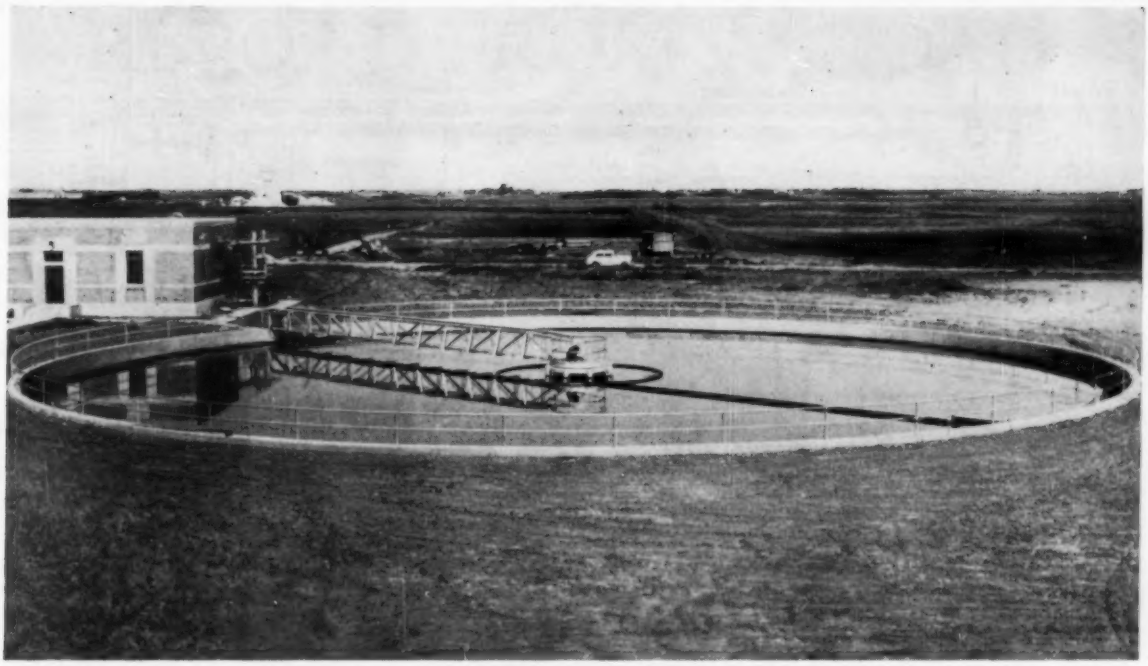
Other Factors Involved

There must be still other factors, therefore, that influence the per cent removal of solids in a tank.

It has been stated that inlet velocity, effluent velocity, turbulence in the tank, density currents, and bed scour are also partially responsible for the degree of clarification obtained in settling tanks.



SMALL Indiana plant has three primary settling tanks to accommodate wide range of flows ahead of activated sludge treatment. Note small collector travel and rotary skimmer (left)



CIRCULAR primary clarifier has central inlet, peripheral overflow weir, and radial sludge and scum collection

When sewage enters a settling tank there is usually a disturbance at the point of entry. This can be expected, inasmuch as the influent port or ports are smaller than the cross-sectional area of the settling tank and the velocity at the port of entry is greater than the velocity through the tank. This high velocity has been noted and efforts have been made to quiet the disturbance at the inlet. A great many methods of admitting sewage to settling tanks have been tried, but even after many years of experience in the use of the different ports no one has the one best way.

The higher the velocity of the entering sewage, the more energy or force is placed on the supposed to be quiet sewage in the tank. If there is a large volume of water in the tank the force of the influent does not cause much turbulence in the tank. However, if the force is large, considerable turbulence can be expected in a settling tank.

Much effort has been expended on the development of baffles at the influent end of the tank. The hope has always been that baffles could be devised that would prevent turbulence in the tank. Probably more attention has been given to the quieting of turbulence than to the elimination of high velocities of the entering stream.

These statements are not made to imply that baffles are not helpful in quieting turbulence in settling tanks. It is believed, however, that if there appears to be considerable turbulence in a settling tank it is a good plan to observe whether the entrance port is being unduly constricted by a weir, gate, or some other control device that could be so modified as to reduce the entering velocity.

Density currents are said to cause difficulty in settling tanks. They can be the cause of some reduction in the per cent removal of solids obtained in primary sedimentation tanks. Density currents may be the result of variations in temperature in various parts of the tank or changes in temperature in the sewage while it is in the tank. The density currents may result from movements of sewages, in the same tank, that have different solids concentrations.

Density currents probably exist to some extent in all primary settling tanks, but it seems that they are probably very minor compared with the turbulence caused by the entering sewage. Perhaps, in time, a settling tank can be designed that will eliminate all turbulence caused by the entering sewage. When that has been accomplished attention can and should then be directed to elimination of turbulence caused by density currents.

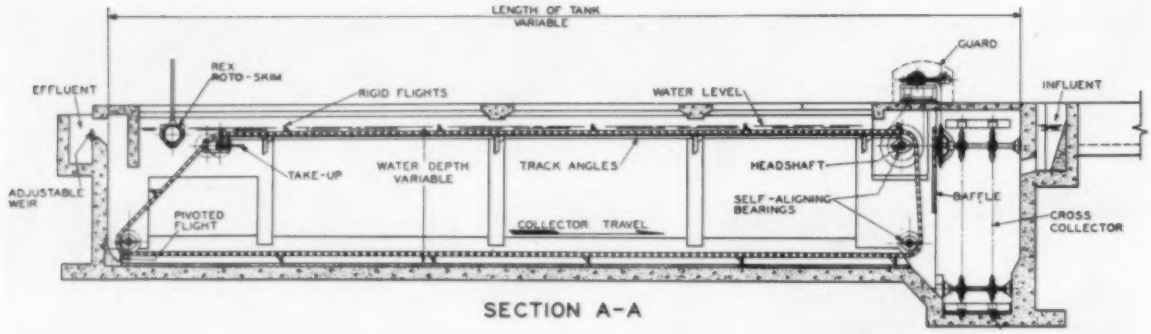
If the effluent is removed at one central point there are apt to be velocities that will disturb the particles that are settling according to the sedimentation laws. The primary settling tanks designed for modern sewage treatment plants have systems of effluent weirs such that the effluent is collected from a fairly large portion of the tank surface.

Of course, when too large a portion of the surface is devoted to effluent troughs there may not be adequate area for scum collection and removal. In most situations it is probably desirable to have as much effluent collection weir length as possible.

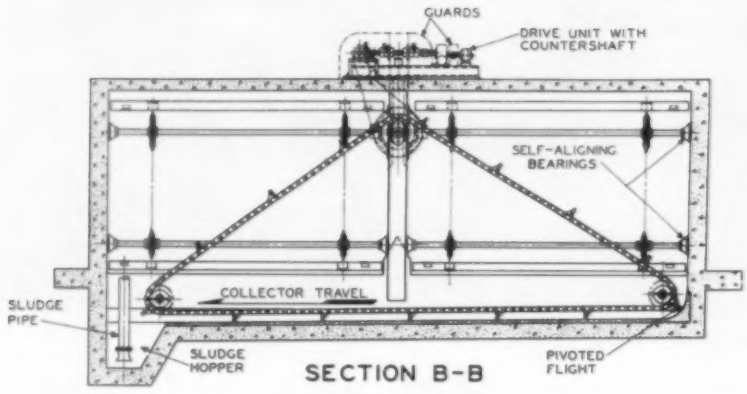
Considerable has been written about the disturbance of settled solids after they have been deposited on the bottom of the tank. "Bed-scour" is the term used to describe the movement of settled solids. It is not likely that deposited solids will be moved from the bottom of the tank by the velocity of flow through the tank. These solids may be disturbed by the turbulence of influent and effluent.

The sludge removal mechanisms may, when operated, move the deposited sludge at such a rate as to put it into suspension again. In most cases the sludge collection mechanism speed has been established by the experienced equipment manufacturer. If there appears to be any sludge disturbance it would be well to check the mechanism speed and determine whether it is greater than 1 foot per minute.

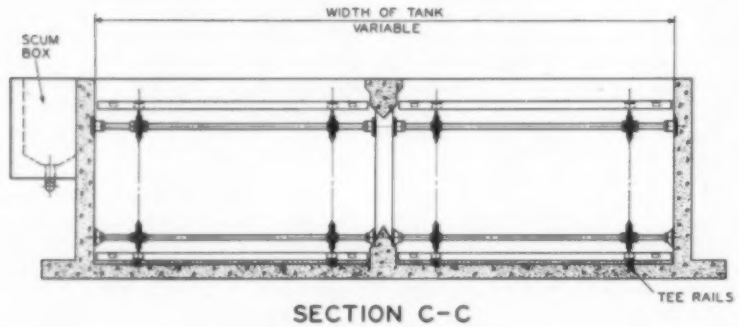
Camp[2] has said: "In the simple theory of sedimentation of discrete particles in an ideal basin it is demonstrated that the removal is a function of the overflow rate and is independent of the tank depth and the



SECTION A-A



SECTION B-B



SECTION C-C

TYPICAL arrangement of mechanism in double primary settling tank

detention time. It follows from the simple theory that the most economical tank will have the least possible depth for the required overflow rate. For a given overflow rate and fixed horizontal dimensions the tank velocity varies inversely as the depth. Hence, the least possible depth is fixed by the maximum velocity that can be used without excessive scour."

It seems that he assumes that there will be time for sedimentation and that the scour lifts the sediment after it has been deposited. In reality, it may be that the sedimentation has never taken place because of the turbulence in the tank. After a number of years of discussion about the rating of settling tanks by the overflow rate method, there are now several design standards that call for the rating of tanks in this way. There are still some designers who hold to the "hours of retention" in a tank as a basis for determining the work load.

The gallons-per-square-foot rating is obtained by dividing the daily flow of sewage by the area of the tank. The removals that can be obtained at various overflow rates are given in Table 1.

It is apparent that settling tanks operating at a loading of 600 gallons per square foot per day should remove about 64 per cent of the suspended solids and that tanks loaded at considerably less than this rate will not have a removal rate much greater than that expected at the 600-gallons-per-square-foot-per-day rate.

Comments have been made about the points of collection of effluent, but no statement has been made relative to the overflow rate per foot of weir. Statements have been made in the various standards of design that the overflow rate per lineal foot of weir should be between 10,000 and 15,000 gallons per foot per day. It is known that tanks operating at this rate remove the expected percentage of suspended solids. It is also observed that these are the overflow rates attained in round tanks with circumferential weirs when loaded near the 600 gallon per square foot per day surface loading rate.

It seems doubtful whether it would be possible to get weir loadings that were too low, but certainly the weirs should not be placed so closely together that the velocity of flow up between the weir troughs was greater than the settling velocity.

TABLE 1
Overflow vs. Suspended Solids Removal

Overflow Rate, gpd/sq ft	Suspended Solids Removal, %
400	68
600	66
600	64
700	63
800	61.5
900	60
1,000	58.5
1,200	56.0
1,400	54.0
1,600	52
1,800	50

Both round and rectangular tanks are used for primary sedimentation. Individual operators usually have a preference for a particular shape. Either type should have mechanical sludge and scum collectors.

References

1. Hazen, A., "On Sedimentation," Transactions Amer. Soc. Civil Engrs., Vol. *58*, p. 63 (Dec. 1904).

2. Camp, T. R., "Sedimentation in the Design of Settling Tanks," Paper No. 2285, Transactions Amer. Soc. Civil Engrs., Vol. *111*, p. 895 (1946).

REPORT FROM ABROAD

The Manchester Report and The Derby Sewage Treatment Studies

by JOHN FINCH

Mr. Finch is Manager of the Sewage Disposal Department, Slough, England. In his reports from abroad he discusses topics and opinions of timely interest. He welcomes the opportunity of replying personally to readers desiring additional information regarding subjects covered in his series.

A REPORT which will be read with very great interest has recently been published by the City of Manchester Rivers Department on the operation of the undertaking for the year ending March 31, 1955.

The particular section of the report which has unusual appeal to sewage treatment authorities, and particularly this year, is that section dealing with the operation of the three types of activated sludge plant, all of which have now been brought up-to-date in the light of modern thought. Thus, the bio-aeration plant has been modified to produce more surface aeration, the diffused air plant has been equipped with the new dome diffusers, and the Simplex surface aeration plant has been fitted with the new "high-intensity" cone which the manufacturer claims to have a much greater effect upon the rate of turnover of the aeration tank contents than the standard cone.

The last unit to be converted (the Simplex surface aeration plant) has now been operating for a good portion of the year under review and it would appear that under the conditions obtaining at the Manchester Davyhulme sewage treatment plant, and dealing with a stale and strong industrial sewage, this unit has the lead on the other two processes—namely, bio-aeration and diffused air.

In point of fact, the operation of the diffused air plant making use of the ordinary conventional porous materials made up into the new domes, has been very disappointing. It has even occasioned the thought in many minds that perhaps the diffused air plant using porous diffusers is now on the way out, not because the process is itself fundamentally unsound, but because the diffusers are inefficient, costly of air pressure, and costly in terms of capital outlay, and are, in fact, now dated as an accessory in the diffused air type of plant.

The main activated sludge plant, which was first brought into service in the year 1935, operates on the diffused air system. This plant has been described on numerous occasions in reports and other publications issued by the Rivers Department. Within recent years, a program of replacing flat porous plate diffusers by a 4-inch diameter dome type of diffuser has been adopted, and only one of the seven units now remains to be converted.

New Dome Diffuser Performance

In 1954, Unit No. 1 was equipped with a complete set of new domes so as to provide a reliable and fair comparison with the modified Simplex surface aeration. The average results of the performance of Unit No. 1 proved to be disappointing. In spells of dry weather the unit did not produce effluents which were satisfactory, even when the retention period in the aeration tank was more than 14 hours and the power consumption per million gallons of sewage treated was in excess of 50 hp.

In spite of the fact that new diffuser domes were fitted in the aeration tank early in the year, by the end of the year air diffusion was in parts so obviously poor that the unit was drained completely; whereupon, it was found that large deposits of sludge lay in the bottom of the aeration tanks around some of the diffusers.

It is stated that it did not appear that the deposits of sludge had come from gritty sludge washed from the primary settling tanks, because the deposits were at about the middle and at the outlet end of the aeration tank, and also in the mixed liquor channel feeding the clarifiers. Analysis of the deposits apparently indicated that the material was similar to activated sludge rather than to the gritty primary sludge.

The pressure of air required by the diffused air units was also much higher than usual and averaged 9.09 pounds per square inch for the year.

Improved Simplex Unit Performance

Towards the middle of 1954, adjustments to the new "high-intensity" cones fitted to the Simplex plant were finally completed by the manufacturers and from that time the plant was operated without a stoppage. From the results produced it was shown that the average daily volume treated during the year by this improved system was just about twice the volume treated by this plant during the year 1953-1954. The average quality of the final effluent produced was rather better than that produced in the previous year and was of Royal Commission standard. The average power requirement per million gallons of sewage treated was 24.3 hp, which was about 14 per cent less than that for the previous year.

The average results produced by this plant during spells of dry weather indicated a detention period in the

BIO-AERATION section of Manchester's Davyhulme plant uses paddle wheels to both move and aerate the sewage, at the same time keeping froth to a minimum. This section of the plant was reported to be more efficient than the other aeration systems in use

aeration tank of between 9.5 and 10 hours and a power consumption of about 28.8 hp per million gallons, which was consistently less than that of either the bio-aeration plant or the diffused air plant.

SIMPLEX plant using high-intensity cone showed next best efficiency in parallel operation with other types of aeration

Compared with the performance of the Simplex plant in dry weather periods before the new cones were fitted, it is apparent so it is said, that the improved unit is now able to treat about 70 per cent more sewage, and at the same time to produce a more satisfactory effluent while requiring less power per million gallons. The Manchester authorities consider that this is probably the most noteworthy improvement in the performance of the activated sludge systems at Manchester since they were installed.

The average composition of the raw sewage dealt with at Davyhulme during the year under review was B.O.D. 224 ppm, suspended solids 226 ppm, and oxygen absorbed (from N/80 permanganate in 4 hours) 114 ppm. Analysis of the settled sewage showed B.O.D. 167 ppm, suspended solids 69 ppm, and oxygen absorbed 87 ppm.

During spells of dry weather, the settled sewage contained 229 ppm B.O.D., suspended solids 79 ppm, and oxygen absorbed 97 ppm. During these periods, the Simplex plant in 9.6 hours produced effluents of B.O.D. 18 ppm, suspended solids 17 ppm, and oxygen absorbed 31 ppm. The diffused air plant produced, in 14.2 hours, effluents containing 24 ppm

B.O.D., 24 ppm suspended solids, and oxygen absorbed 34 ppm.

Note on Froth Production

It is also stated that froth produced on the diffused air plant has continued to be a nuisance, whereas that produced on the Simplex plant has been confined mainly to the corners of the aeration pockets situated towards the outlet end of each line of cones, and has not been unduly troublesome.

The Manchester authorities have been exceedingly forthright in their statements and all interested authorities are now eagerly awaiting the reactions to these statements.

DIFFUSED AIR plant was least efficient of three types used at Davyhulme plant

Derby Sewage Treatment Scheme

Many will remember the *cause celebre* two or three years ago in which the little angling club "The Pride of Derby," backed by the powerful Anglers' Association, took action against the Derby Corporation and Messrs. British Celanese for polluting the river. As a sequel to that action, a joint meeting of the Institute of Sewage Purification and the Institution of Municipal Engineers was held at Derby on October 20, 1955, to inspect the work being carried out by Derby Corporation at its sewage disposal plant to meet the High Court Order made against them and against Messrs. British Celanese, Ltd., in 1952, to cease polluting the River Derwent.

Prior to the court proceedings, consulting engineers were asked to submit observations and a detailed report indicating the scope of the treatment works which were desirable to facilitate the disposal of the estimated sewage flow of the town within 20 years. The consulting engineers' report suggested that the measures necessary included, among other things, grit removal and comminution, modification and mechanization of the existing primary settling tanks, modification of the existing storm water tanks, construction of new humus tanks, provision of a degree of recirculation, and provision of heated sludge digestion with the collection of gas.

No final recommendation concerning the dewatering of the heated digested sludge was made in the report, although an allowance was made in the estimates for provision of vacuum filtration and a heat drying plant.

In a further report (May 1952), the consulting engineers put forward their immediate proposals for remedial work which could be carried out within two years of that date. These proposals provided for such works as seemed best calculated to improve the state of the river as quickly as possible, a considerable amount of plant-scale research and investigational work, and the design of further works with a similar object but taking a longer view and including the ordering of materials and plant for which the delivery period was prolonged.

Included in primary proposals were microstrainers to reduce the suspended solids in the filter effluent. The plant-scale investigations indicated a modification of the 1951 report and in 1954 it was decided that the new works should be designed to operate as an alternating double filtration scheme instead of a recirculation scheme.

The pilot plant used in these investigations was constructed at the sewage treatment plant by Messrs. British Celanese, who in 1952 sought the corporation's consent to the discharge to the sewage treatment plant of a trade waste from their Spondon factory averaging about 6 mgd and having a B.O.D. after settlement of about 450 ppm.

The first series of experiments lasted for about a year. With clinker as the filter medium, and with a dose of 150 gallons per cubic yard per day, the pilot plant was operated as three separate units; that is, straight filter scheme, a recirculation scheme, and as an alternating double filtration scheme.

The mixture fed to the filters consisted of Derby settled sewage and Celanese wastes mixed in the proportions of 9:6, representing a dry weather flow of sewage of 9 mgd and 6 mgd of Celanese effluent.

The results of the operation of all three systems were very good, with B.O.D. values for the final effluents after settlement in the range 5 to 10 ppm, suspended solids 5 to 15 ppm, and four-hour oxygen absorbed in the range of 10 to 15 ppm. In this respect, the alternating double filtration unit gave very slightly better results than the other two methods, and particularly was this so in the winter months.

As a result of this experimental work the Corporation decided to accept the British Celanese discharge and decided to design the scheme in terms of alternating double filtration. The investigational work continues.

Microstrainers were installed as a temporary measure to remove the greater part of the suspended solids remaining in the humus tank effluent. However, it is still rather difficult to assess the true performance of the microstrainers since their installation because of the rapidly changing conditions caused by the rebuilding of the sewage treatment plant. In point of fact, during the wet summer and winter of 1954, when work was in progress on the storm water tanks and the sedimentation tanks, producing a reduced effective capacity, the conditions were so bad that poor settled sewages high in suspended matter were produced. This in turn overloaded the percolating filters and the final effluent to the microstrainers was of a much poorer quality than anticipated.

After some modifications to the feed to the microstrainers, it was found that a reduction in suspended matter of about 33 per cent was obtained with an attendant improvement in the B.O.D. and the O.A. values. It was stated that to keep the microstrainers in good condition required washing in a hypochlorite solution every three or four days to remove the accumulated bacterial slime.

Do We Speak the Same Language?

An open letter from one superintendent to another on the misreading of directions

Dear Bill,

For some time now, I've been watching a television show that demonstrates how to "do it yourself" with aluminum rods, bars, plates, bolts, screws and rivets. It looked so easy. I finally succumbed to the lure of advertising and purchased some material to make a storm window for a small skylight in my office.

After several false starts, bruised knuckles, and perplexed brow, I read the directions and—what do you know—I did it myself and the window is now complete and ready to install come that cold day in November. But the experience brought to mind a situation that exists all too often in everyone's plant, including yours and mine.

We, and our men, don't read directions before starting to do some job like installing or operating a piece of equipment. Or, if we do read the directions we don't interpret them correctly.

It Says Here

Last week, I visited a water plant not far away. I started to choke and cough because there was so much lime dust in the air. I found the operator dumping lime in the hopper of a chemical feeder in the next room. Naturally, the thought occurred to me that here was a fellow who could use a dust collector. And then I saw it—a dust collector, I mean, brand new.

The operator was wearing a mask and I asked him why he didn't use the dust collector. "Oh, we do use it, but we can't turn it on until two minutes after we have finished dumping the lime."

"Why not," I asked.

"Well, it says right on the switch cover plate—'After overload, wait two minutes, then turn on'."

Backwards or Forwards

That reminds me of the article some fellow wrote where he told of a new sewage plant in which it was found that 29 motors had been hooked up to run backwards.

I remember another instance where the operator couldn't get any chlorine residual, no matter how much chlorine he added. So he called the chlorinator service man, who took very few minutes to find out that the operator had used a cylinder of sulfur dioxide instead of chlorine. The SO_2 tag was still on the cylinder cap and of course the cylinder and cap were a different color than those used for chlorine containers.

Silly Sampling

When I was running an industrial survey, once, I set up a sampling schedule whereby individual samples were to be collected every 15 minutes and then composited hourly, so we would have 24 individual samples to analyze each day, but representing 96 individual sampling efforts. I don't suppose I would ever have known the difference, if I hadn't visited the sampling crew one night and found that they had their own interpretation of the directions.

They took a gage reading, entered it in the log, and then took a sample. Fifteen minutes later they took another reading and another sample, after they had dumped out the previous sample. They did this three times and on the hour they took a reading and a sample and they saved that sample.

In another instance, a sampling crew was collecting samples from a sewer in which we had built a V-notch weir. They were told how to take a gage reading, then place the sample bottle under the weir discharge until it was full. When I saw the samples, they just didn't look right—too much gunk in them. I found that the crew was taking the gage reading O.K., but instead of filling the bottle under the discharge, they were submerging the bottle behind the weir, where it was filled with solids that had settled out behind the weir.

Servicemen's Stories

Some of the equipment manufacturers' service men who have called on me have told me some honeys about operators who don't believe their eyes. There was the fellow who bought a gravimetric loss-in-weight chemical feeder, then complained that it operated only as a volumetric feeder. Here's what he was doing. You know, when you fill the hopper of one of those machines, you lock the scale beam and you unlock it when the hopper is filled. He never unlocked the beam, although the directions explained exactly how to do it.

Service men make mistakes, too. Take the case of the two cities on opposite sides of a river, both with flow measuring equipment in their sewage plants. One of them ordered a maintenance service job. The service man arrived, did the job and was ready to leave when the superintendent came in and pointed out that the order was from the plant across the river!

Perfect Heating

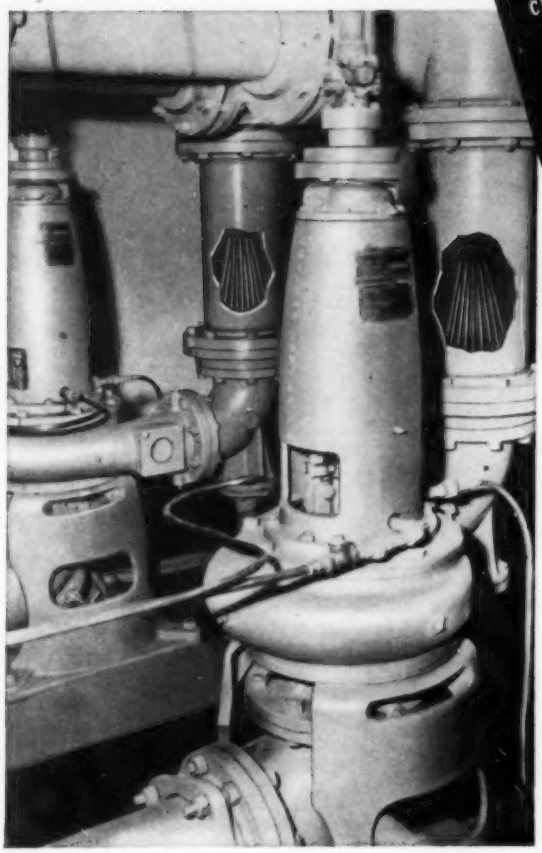
This happened in my own plant. We have a hot water coil system for heating our sludge digesters. One of the operators remarked about how well the heating system was working, now, on one of the digesters. The temperature chart showed an absolutely straight line on that digester. For more than a year, he had changed charts every day and each chart had a distinctive pattern of ups and downs that corresponded with raw sludge additions. Now, for two weeks, one tank had shown a straight line while the others had shown the distinctive ups and downs. He thought the heating system had improved in that tank. It never occurred to him that the connection to the thermocouple on that tank was broken.

Follow Directions Explicitly

It's said that the trouble with us Americans is not that we know so much, but that we know so much that isn't true. Yes, and doggone it, when we read things, we see something that isn't there.

Maybe we should start a "Society for the Prevention of Stupid Reading," but in spite of the seriousness of the problem at times, these mental lapses or whatever they are, are good for a laugh—if they happen to someone else.

Yours, Ted



CHICAGO SEWAGE EQUIPMENT

FLUSH-KLEEN® Sewage Ejectors

More than 12,000 installed in lift stations, buildings and ships

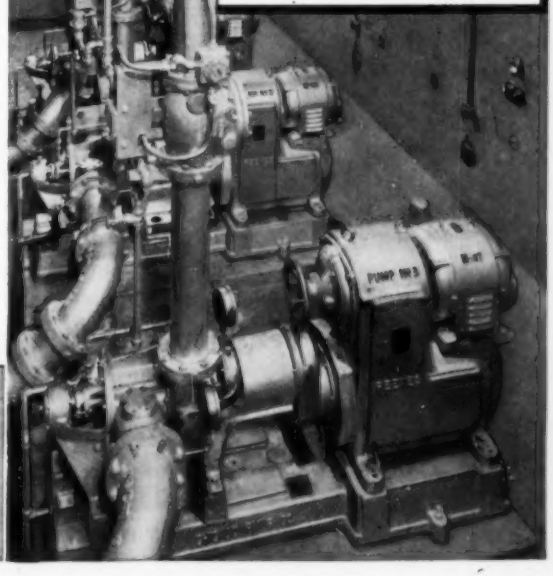
Flush-Kleen sewage ejectors can't clog because rags never reach the impeller. Specially designed strainers in the discharge line retain all coarse matter. Sewage flows over the strainer and through one of the pumps to the wet well. When the pumps operate alternately they pump only strained sewage. No rags or coarse material ever pass through the pump casing. Each strainer is automatically flushed clean during its pumping cycle.

One of 11 Flush-Kleen sewage ejector lift stations installed in the City of Portland, Oregon. The discharge line has been cut away to show the strainer. These stations were designed by Stevens and Koon the Engineers for Portland Sewerage Project.

CHICAGO SEWAGE EQUIPMENT

SCRU-PELLER® Sludge Pumps

OVER 8,000 IN SERVICE



Scru-Peller pumps are designed specifically for pumping primary sludge, are positive in operation and truly clog-proof.

Continuous multiple shearing action is provided by stellited cutting edges of the screw and eight stellited cutting bars positioned in the screw and pump housings.

Heavy-duty ball bearings at each end of the screw and impeller shaft eliminate strain and vibration, permitting pump to withstand sudden and severe overload shocks.

Three of the 27 Scru-Peller pumps installed at the Hyperion Sewage Treatment Plant, Los Angeles, California. Board of Public Works and Metcalf & Eddy, Engineers.

Write to Department J

fmc

CHICAGO PUMP COMPANY

Subsidiary of Food Machinery and Chemical Corporation

SEWAGE EQUIPMENT DIVISION

621 DIVERSEY PARKWAY • CHICAGO 14, ILLINOIS

Flush Kleen ®, Scru-Peller ®, Plunger, Horizontal and Vertical Non-Clogs Water Seal Pumping Units, Samplers . . . Swing Diffusers, Stationary Diffusers, Mechanical Aerators, Combination Aerator-Clarifiers, Barminutor ®, Comminutors.

Is Corrosion "Eating Up" Your Profits?

investigate

Van-Cor

PIPE, FITTINGS, VALVES

Van-Cor is an unplasticized polyvinyl chloride that resists the corrosive action of hundreds of industrial acids and alkalis as well as sewage waste and brine. Van-Cor piping costs less, is lighter in weight, and easier to install than conventional pipe. It is readily formed, machined, threaded and welded. On many installations where metallic piping was eaten up *in a few months,* Van-Cor pipe has served *for years without deterioration.* Thus it quickly returns its cost and pays handsome dividends.

Van-Cor sheets are also fabricated into ducts, hoods, chemical tanks, fumestacks, etc.

INVESTIGATE!

Write for Bulletin, Specifications and Name of Nearest Distributor.

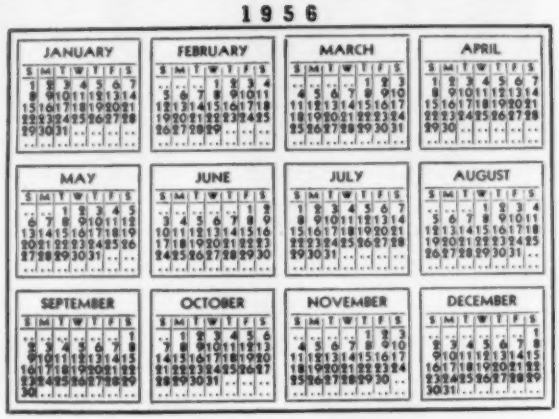
INDUSTRIAL DIVISION OF
COLONIAL PLASTICS MFG. CO.

SUBSIDIARY OF THE VAN DORN IRON WORKS CO.
2685 EAST 79th STREET • CLEVELAND 4, OHIO

W & SW

Meetings Scheduled

1956



Feb. 8-10—Indianapolis, Indiana *(Lincoln Hotel)*
INDIANA SECTION, A.W.W.A., Secy., Robert J. Becker, Indianapolis Water Company, 113 Monument Circle, Indianapolis 6, Ind.

Feb. 13-17—Dallas, Texas *(Baker Hotel)*
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Exec. Secy., W. H. Wisely, 33 W. 39th St., New York 18, N. Y.

Feb. 14—Newark, N. J. *(Essex House)*
NEW JERSEY SECTION, A.W.W.A., C. B. Tygert, Secy., Box 178, Newark 1, N. J.

Feb. 14-17—Los Angeles, Calif. *(Mayfair Hotel)*
CALIFORNIA MUNICIPAL UTILITIES ASSOCIATION, 24th Annual Conference, Secy. F. V. Frey, Room 108, City Hall, Pasadena, Calif.

Feb. 26-29—Los Angeles, Calif. *(Statler Hotel)*
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
F. J. Van Antwerpen, 25 W. 45th St., New York 36, N. Y.

Feb. 26-29—Fort Worth, Tex. *(Texas Hotel)*
TEXAS PUBLIC HEALTH ASSOC., V. M. Ehlers, Secy., Dept. of Health, 2202 Indian Trail, Austin, Tex.

Mar. 4-9—College Station, Tex.
TEXAS SEWAGE & WATER WORKS ASSOC. (Annual Short School)
Texas A & M College, V. M. Ehlers, Secy., State of Tex., Dept. of Health, 2202 Indian Trail, Austin, Tex.

March 12-16—New York, N. Y. *(Hotel Statler)*
NATIONAL ASSOCIATION OF CORROSION ENGINEERS, A. B. Campbell, Exec. Secy., 1061 M & M Bldg., Houston 2, Tex.

Mar. 14-16—Atlantic City, N. J. *(Traymore Hotel)*
NEW JERSEY SEW. & IND. WASTES ASSOC., Michael S. Kachorsky, Sec.-Treas., P. O. Box 766, Manville, N. J.

Mar. 18-21—Augusta, Georgia *(Bon Air Hotel)*
SOUTHEASTERN SECTION, A.W.W.A., Secy., N. M. deJarnette, Engr., State Dept. Pub. Health, 245 State Office Bldg., Atlanta 3, Ga.

Mar. 18-19—Little Rock, Ark. *(Marion Hotel)*
ARK. WATER & SEWAGE CONF., Harrison Hale, Sec.-Treas., Southern State College, Magnolia, Ark.

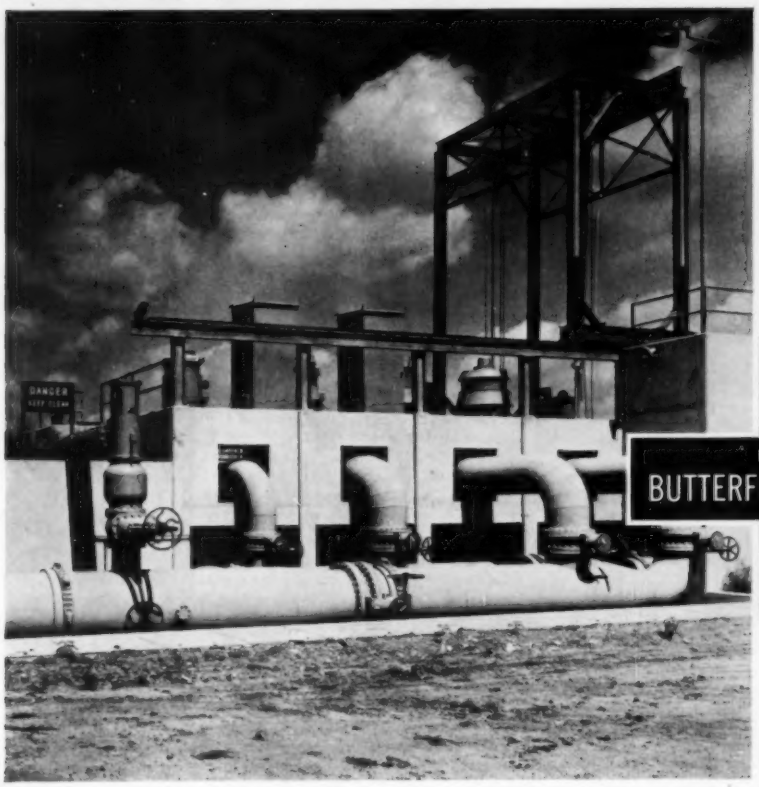
Mar. 21-23—Chicago, Illinois *(LaSalle Hotel)*
ILLINOIS SECTION, A.W.W.A., Secy., Dewey W. Johnson, Cast Iron Pipe Research Association, 122 So. Michigan Ave., Chicago 3, Ill.

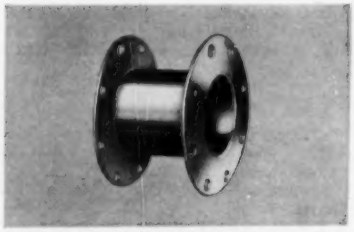
Apr. 3-5—Philadelphia, Pa. *(Bellevue-Stratford Hotel)*
PENNSYLVANIA SECTION, A.W.W.A., Secy., L. S. Morgan, State Dept. of Health, Greensburg, Pa.

Apr. 4-6—Topeka, Kansas *(Jayhawk Hotel)*
KANSAS SECTION, A.W.W.A., Secy., Harry W. Badley, 119 W. Cloud, Salina, Kansas.

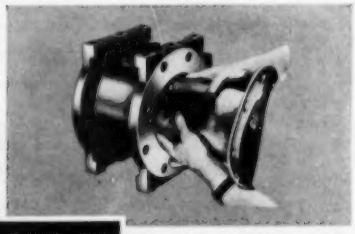
(Continued on page 84A)

Use of compact R-S Rubber-Seated Butterfly Valves in this common header permitted close coupling of all pipe, resulted in a substantial saving.

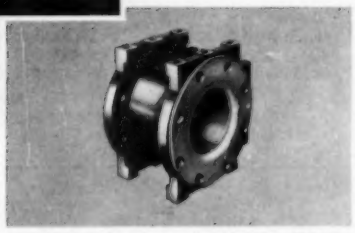




Renewable & replaceable rubber seat . . .



. . . Is installed in valve body . . .



. . . And positions with flanges fitting body flange holes . . .

R-S BUTTERFLY VALVES

FOR DROP-TIGHT SHUT-OFF AND ABRASION RESISTANCE

R-S Rubber-Seated Butterfly Valves give 100% effective shut-off with 125-pound pressure drop. Wedge-type action of the vane against the tough flexible rubber seat gives positive closure even around the shaft bosses. The special composition of rubber and other materials gives long wear and resistance to the flow of materials.

Use of R-S Butterfly Valves in place of conventional gate valves will give a far more compact piping layout. This can mean substantial savings in the initial building cost. To get full information on the complete line of Butterfly Valves, Ball Valves, and Rotovalves, see our local representative or write S. Morgan Smith Co., York, Pa.

HYDRAULIC TURBINES
PUMPS
GATES & HOISTS
TRASH RAKES
ACCESSORIES

HYDRODYNAMICS

ROTOVALVES
BALL VALVES
BUTTERFLY VALVES
FREE-DISCHARGE VALVES
CONTROLLABLE-PITCH SHIP PROPELLERS

SMS

S. MORGAN SMITH

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

Apr. 4-6—Topeka, Kansas *(Jayhawk Hotel)*
KANSAS SEWAGE & INDUSTRIAL WASTES ASSN., Robert H. Hess, Sec.-Treas., Dept. of Water Supply & Sewage Treatment, City Building, Wichita, Kansas.

Apr. 5-6—Chapel Hill, N. C. *(Carolina Inn)*
FIFTH SOUTHERN MUNICIPAL & IND. WASTE CONF., Daniel A. Okun, Univ. of North Carolina, Chapel Hill, N. C.

Apr. 5-7—Safford, Ariz. *(Buena Vista Hotel)*
ARIZONA SECTION, A.W.W.A., Secy., Quentin M. Mees, Ariz. Sewage & Water Works Assn., 721 N. Olsen Ave., Tucson, Ariz.

Apr. 5-7—Safford, Arizona *(Buena Vista Hotel)*
ARIZONA SEWAGE & WATER WORKS ASSN., Quentin Mees, Sec.-Treas., 721 N. Olsen Ave., Tucson, Ariz.

Apr. 6-7—Livingston, Montana *(Murray Hotel)*
MONTANA SECTION, A.W.W.A., Secy., A. W. Clarkson, State Board of Health, Helena, Montana.

Apr. 11-13—Lincoln, Nebraska *(Cornhusker Hotel)*
NEBRASKA SECTION, A.W.W.A., Secy., John E. Olsson, 922 Trust Bldg., Lincoln, Nebr.

Apr. 18-20—Utica, New York *(Hotel Utica)*
NEW YORK SECTION, A.W.W.A., Secy., Kimball Blanchard, 56 Grand St., White Plains, N. Y.

Apr. 19-20—Natural Bridge, Va. *(Natural Bridge Hotel)*
VIRGINIA IND. WASTES AND SEW. WORKS ASSN., J. L. Hamrick, Sec.-Treas., 415 W. Franklin St., Richmond 20, Va.

Apr. 23-25—London, Ontario *(Hotel London)*
CANADIAN SECTION, A.W.W.A., Secy., A. E. Berry, 72 Grenville St., Toronto, Ont., Canada.

Apr. 25-28—Santa Rosa, Calif. *(Santa Rosa Hotel)*
CALIF. SEW. & IND. WASTES ASSN., J. C. Mallery, Sec.-Treas., 4822 N. Dunsmore Ave., LaCrescenta, Calif.

Apr. 26-28—Victoria, B. C. *(Canada Empress Hotel)*
PACIFIC NORTHWEST SECTION, A.W.W.A., Secy., Fred D. Jones, Distr. Supervisor, Rm. 305, City Hall, Spokane, Wash.

May 6-11—St. Louis, Mo. *(Diamond Jubilee Conference)*
A.W.W.A. CONVENTION, Secy., Harry E. Jordan, A.W.W.A. Assn., 521 Fifth Ave., New York 17, N. Y.

May 14-16—St. Joseph, Michigan *(Whitcomb Hotel)*
MICHIGAN SEWAGE & INDUSTRIAL WASTES ASSN., Donald M. Pierce, Sec.-Treas., Dept. of Health, Administration Bldg., Lansing 4, Michigan.

May 15-17—Lafayette, Indiana *(Purdue Memorial Union)*
PURDUE 11TH INDUSTRIAL WASTE CONFERENCE, Chairman, Prof. Don E. Bloodgood, C.E. Bldg., Purdue University, Lafayette, Indiana.

May 17-19—New York, New York *(Statler Hotel)*
THE NEW YORK STATE SOCIETY OF PROFESSIONAL ENGINEERS 30TH ANNUAL CONVENTION & EXPOSITION, George Baer, Chairman, N. Y. State Society of Professional Engineers, Inc., 1941 Grand Central Terminal, New York 17, N. Y.

May 28-29—Buffalo, New York *(Hotel Statler)*
NEW YORK SEWAGE & INDUSTRIAL WASTES ASSN., R. C. Sweeney, Exec. Secy., State Dept. of Health, 21 North Broadway, White Plains, N. Y.

June 4-6—Auburn, Alabama *(Ala. Polytechnic Institute)*
ALABAMA WATER & SEWAGE ASSN., W. L. Samuel, Sec., Byrd L. Moore & Co., Box 143, Fairhope, Ala.

June 4-8—Knoxville, Tenn. *(University of Tennessee)*
AMERICAN SOCIETY CIVIL ENGINEERS, Exec. Secy., W. H. Wisely, 33 West 39th St., New York 18, N. Y.

June 13-15—Cleveland, Ohio *(Carter Hotel)*
OHIO SEWAGE & INDUSTRIAL WASTES TREATMENT CONFERENCE (30th Annual Meeting) Ward E. Conrad, Sec.-Treas., 301 Ohio Depts. Building, Columbus 15, Ohio.

June 17-22—Atlantic City, N. J. *(Chalfonte Haddon Hall)*
AMER. SOC. FOR TESTING MATERIALS, Asst. Secy., Fred F. Van Atta, 1916 Race St., Philadelphia, Pa.

June 20-22—Green Bay, Wisconsin *(Northland Hotel)*
CENTRAL STATES SEWAGE & INDUSTRIAL WASTES ASSN., Geo. F. Bernauer, Sec.-Treas., 713 Chapman Street, Madison, Wis.

August 29-31—University Park, Penna. *(Pennsylvania State University)*
PENNSYLVANIA SEWAGE & INDUSTRIAL WASTES ASSN., J. R. Harvey, Sec.-Treas., 916 Diamond, Meadville, Pa.

Sept. 9-12—Pittsburgh, Pa. *(Wm. Penn Hotel)*
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
F. J. Van Antwerpen, 25 West 45th St., New York 36, N. Y.

"AFTER-RAIN" Sewer Stoppages
...no longer a worry at Johnstown, Pa.

Just trying to **open** one 12" Storm Sewer, after a rain, used to be a **2 or 3 day job** in Johnstown, Pa. After the last rain, they put their new SeweRodeR to the test. It not only **opened—but cleaned** this line in a single day. What's more the pleased sewer crew (from right to left—Foreman Herman Weiman, and Operators Frank Zdnovec and Colon Griffin) did the job without touching a rod or working in the manhole. The SeweRodeR performs all operations mechanically, eliminating 9/10's of the hard labor.

Arrange to see the SeweRodeR in operation—not on a routine job, but on a tough assignment—and you will agree with Johnstown, Pa. that investment in a SeweRodeR is one way to get the most for the Taxpayers' Dollar.

FLEXIBLE
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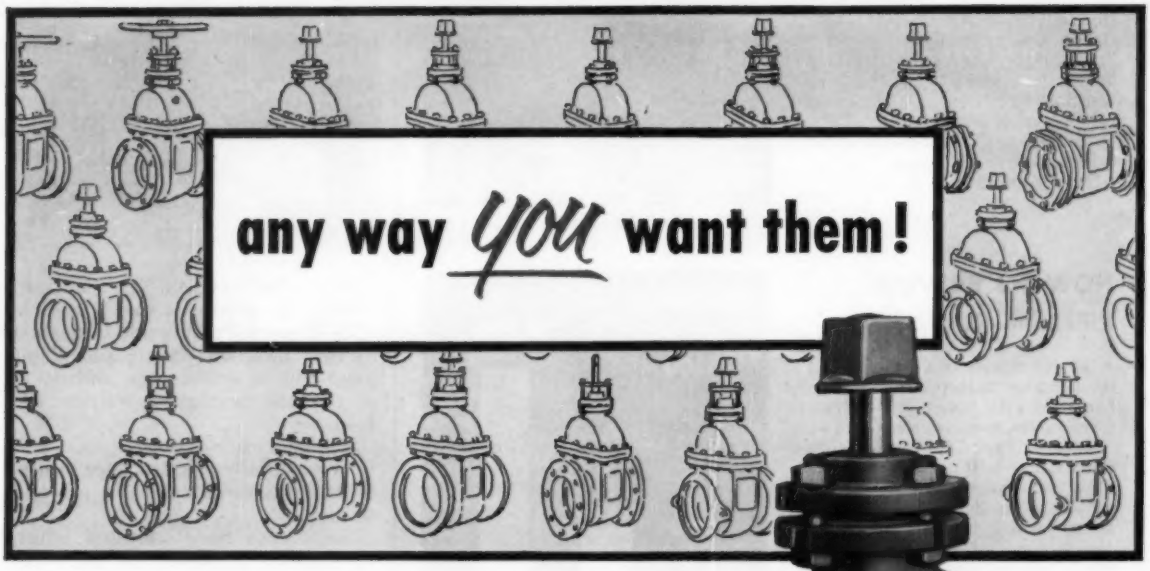
Los Angeles 34, Calif.

(Distributors in Principal Cities)

MUELLER®

GATE VALVES



O. S. & Y. or non-rising stem

Outside screw and yoke (O.S.&Y.) or non-rising stem gate valves can be furnished with bevel gears for horizontal installation or spur gears for vertical installation.

"O" ring or conventional stem packing

Two "O" rings, one located above the thrust collar and the other below the thrust collar provide a positive seal against leakage around the stem. The higher the pressure, the greater their sealing force. Lubricant, sealed between "O" rings keeps thrust collar permanently lubricated. Conventional packing is kept tight with packing gland flange adjusting bolts. Valve can be repacked without removing packing gland.

Choice of ends

A wide selection of ends – hub, screwed, flanged, universal, mechanical joint or spigot with many different combinations make the Mueller gate valve adaptable to any main.

For complete information, consult your W-96 Catalog, your Mueller Representative, or write direct.

MUELLER CO.

Dependable Since 1857

MAIN OFFICE & FACTORY DECATUR, ILLINOIS

• If interested in equipment or literature mentioned below, mail a Reader Service Card with your name, address, and item key number.

COST CUTTING

HOW TO PREVENT PIPELINE COLLAPSE

• A break in the line or a quickly opened valve often releases water at terrific velocity. Internal pressure falls below atmospheric. Thin-walled pipelines collapse!

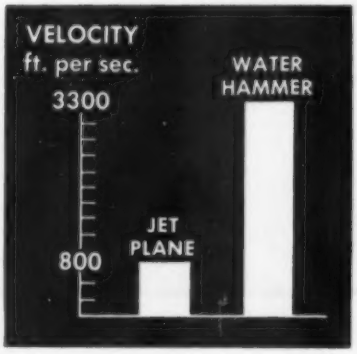
Simplex Air Inlet Valves quickly admit air, prevent a vacuum, protect lines from collapse. They also vent air when lines are being filled to stop binding, increase efficiency. Standard 4" to 10" sizes. BULLETIN 1202

Pipeline collapse due to vacuum

HOW TO PREVENT PIPELINE RUPTURE

• Sudden closure of a valve can set up hammer that travels 4 times faster than the fastest jet . . . fractures valves, ruptures long lines.

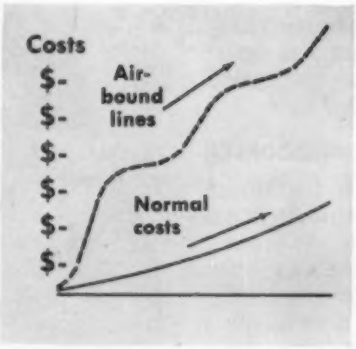
Simplex Type CCAV Valve ends these dangers. It controls transfer time, and releases both air and water to prevent damage. And lets in air to prevent vacuum collapse if breaks occur or lines are drained. BROCHURE



HOW TO CUT PUMPING COSTS

• When air lodges in high spots, it cuts the effective area of pipe, creates a friction head, lowers pumping capacity . . . and may cause water-hammer.

Simplex Air Release Valves end these troubles. They vent air automatically to eliminate binding, increase efficiency, cut pumping costs. Simple, rugged 2" size, for up to 250 psi., costs you little, quickly pays for itself! BULLETIN 1200



WRITE for Technical Bulletins! Simplex Valve & Meter Company, Dept. WS-2, 7 E. Orange St., Lancaster, Pa.

Accurate instruments and controls since 1904

SIMPLEX®

VALVE AND METER COMPANY

W&SW

New Equipment

New Plastic Tile Clip Prevents Drainage Field Failure

201

Boco Industries, Inc., Detroit, Mich., has developed the Boco Tile Clip, designed to provide a method of easy drain tile laying and alignment and to prevent the infiltration of fine soil from above into the tile field.

The clip, made of polyethylene, said to be practically indestructable, resists acids and alkalies found in soil and sewage.

Boco clips have two lugs which fit between adjoining tile and take the guess work out of spacing. When the adjoining tile are butted against these lugs they are automatically spaced ⅜ inch apart. It is molded to fit snugly against the outer surface of the tile and the fin on top serves the dual purpose of a handle and as a guide to proper alignment of the tile.

Turbine Meter

202

Fischer & Porter Company, Hatboro, Pa., has developed a new turbine flow meter featuring wide range and high accuracy.

The F & P Turbine Flow Meter gives precise flow rate measurement (plus or minus ½ of 1 percent of rate) up to 100,000 pounds per hour at specific gravity 1.0. Range is 20:1. Accuracy is not affected by piping configuration. Maximum pressure drop is 7 psi.

The meter consists of a fluid-driven rotor mounted in a short housing installed in the pipe line. The rotor turns at a speed directly proportional to the fluid velocity. The blades of the rotor are of a magnetic material, and as each blade passes a pickup coil contain-

(Continued on page 88A)

What's being done with Uscolite Pipe these days?

A great deal, because Uscolite® is tough, rigid, lightweight, corrosion-resistant, makes a tight, firm joint. Consider these points:

When you say Uscolite is tough and strong, just how tough and strong do you mean?
Won't break if dropped or hammered. It needs no coddling. Can be set and threaded on the job with standard pipe tools. Stands up under the most severe conditions.

What will Uscolite pipe carry?
Uscolite has excellent chemical resistance. It's especially recommended for carrying corrosive chemicals and materials sensitive to contamination. It's valuable for piping through highly humid and corrosive atmosphere. It works under the most severe conditions.

Is Uscolite a tested product?
Yes. Uscolite pipe and fittings have been proved by years of service in thousands of installations in dozens of different industries.

Is Uscolite difficult to install?
On the contrary. It is available in both the standard and the extra-heavy wall iron pipe sizes. It is easy to cut and thread with standard equipment and install without special precautions. The pipe can be drilled, tapped, sawed and machined.

Is the Uscolite line complete?
Yes. It includes elbows, tees, flanges, couplings, reducing bushings, caps, valves—everything to make a complete pipe assembly.

How do I know if Uscolite is right for my requirements?
The odds say overwhelmingly that Uscolite pipe and fittings can save you money. Contact any of our 27 District Sales Offices, each staffed with engineers, to help solve any of your pipe problems. Or write us at Rockefeller Center, New York 20, N. Y.

US RUBBER

Mechanical Goods Division

United States Rubber

ing a magnet, it induces an electrical pulse. The number of pulses produced is directly proportional to the speed of blade rotation and number of blades.

New Coating Provides "Cold Galvanize" Finish

203

Amercoat Corporation, South Gate, Calif., has developed a new protective coating called "Dimetcote" that is said to provide existing steel structures the same protection that galvanizing affords, plus salt water resistance.

Not a paint, although applied with either brush or spray, Dimetcote is a 100 per cent inorganic, metallic zinc coating that contains no oils or resins. Only one coat is required for most applications. The material cost is less than $0.06 per square foot.

Dimetcote is unusually resistant to severe weathering and abrasion, and is excellent for structural steel, railings, grating, gates, and all areas exposed to water corrosion.

A unique feature of the coating is that the film cathodically inhibits corrosion of contiguous areas of bare steel. According to the manufacturer, when it is applied, a reaction takes place at the surface which produces chemical bonding as well as physical adhesion, so that it is almost impossible to find the interface.

New Coagulant Aids

204

Hagan Corporation, Pittsburgh, Pa., has announced, as a result of research and development by its subsidiary, Hall Laboratories, Inc., the development of three new coagulant aids designed to speed up water clarification processes.

According to the company, the new coagulant aids make coagulants such as aluminum and iron compounds more efficient in removing turbidity from water. The aids cause flocs of aluminum or iron hydroxides, which enmesh finely divided sediment, to form more quickly and to settle more rapidly. The materials also make it possible to clarify raw water over a broader alkalinity or pH range than would otherwise be possible. Even without coagulants, the aids help in the formation of larger faster-settling precipitate in lime-soda softeners.

Submersible Booster Pump

205

Layne & Bowler Pump Company, Los Angeles, Calif., and General Electric have joined in producing the Verti-Line Submersible Booster Pump designed specifically to meet the rigid requirements of industrial and municipal pump users.

The submersible type pump has been designed for industrial applications and is said to provide invisible and noiseless operation, greater safety for both people and equipment, extra dependability in any weather, minimum space requirements, and virtually maintenance-free performance without need of adjustment or lubrication.

In order to meet the varied demands of industrial application, the Verti-Line Submersible Booster Pump embodies many refinements such as: oversize shaft, longer bearings with protective caps, perihedral impeller seals, mechanical shaft seal designed specifically for submerged service, and a choice of either mixed-flow or radial-flow impellers. The General Electric Submersible Motor has a larger oil reservoir and a spring-loaded resilient bag which permits the sealed

(Continued on page 90A)

have you met

Mr. Centriline . . .

If not, you should! He can do things for you . . . like making your job easier and saving you money. He's a versatile and somewhat ingenious many-armed creature who specializes in cement-mortar lining the inside of pipes. And he's done this to over 4 million feet of pipe, too—eliminating corrosion and tuberculation . . . increasing flow capacity . . . reducing leakage . . . slashing pumping costs . . . and adding years and years of pipe life. If you'd like to learn more about Mr. Centriline and how he can work for you, just write or call for one of our descriptive brochures.

CENTRILINE CORPORATION

A subsidiary of the Raymond Concrete Pile Company

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WOrth 2-1429

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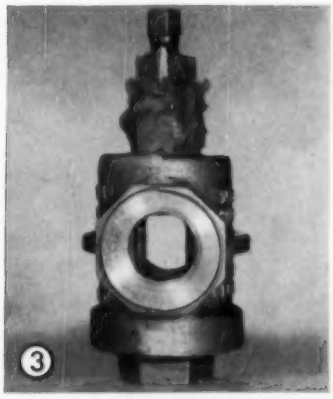
• CEMENT-MORTAR LINING OF PIPES IN PLACE •

*SEE HOW *Controlled*
PRESSURIZED LUBRICATION
GUARANTEES LOWEST COST SERVICE FROM

HOMESTEAD *lubricated* PLUG VALVES

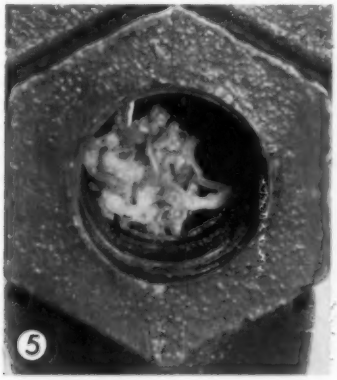
This plug was removed from a Homestead Valve just after starting lubrication, and before all sealing areas were filled with lubricant. Note that pressurized lubricant continues to extrude through feeder holes. Momentary downward movement of plug at start of each lubrication, gives assurance that plug is always free to turn.

The plug was again withdrawn from the valve body just after a ring of lubricant around the stem indicated that the lubricant system was full. Note that all lubricant grooves are filled. The entire plug surface is coated with lubricant. Lubricant is well packed in the stem sealing area above the plug.



Now valve has been purposely over-lubricated as indicated by excess lubricant around stem. Note that with *controlled* pressurized lubrication there is no extrusion or seepage of lubricant into valve port opening. This means no waste, no contamination of line fluids, no clogging of low pressure lines with lubricant, or fouling of meters, orifices, etc.

Also, in the Homestead Valve with *controlled* lubrication, you will note that even though the valve has been over-lubricated, lubricant comes only to the bottom edge of the plug, and is not wasted by discharging in quantity into the bottom chamber.



Now, see for yourself the risk involved when a valve which does *not* have Homestead's *controlled* Pressurized Lubrication, is over-lubricated. Note lubricant has been forced into the port opening. It can contaminate line fluids, foul meters or orifices, or even block low pressure lines!

* Unretouched photos.

These are but a few of the many advantages of Homestead's controlled pressurized lubrication that guarantee lowest cost valve service.

Reference Book 39-5 has the full story—twenty-eight pages of engineering facts, sizes, types, dimensions, etc. Ask for your copy today. There is no obligation.

HOMESTEAD LUBRICATED PLUG VALVE (Pat. Pend.)

HOMESTEAD VALVE MANUFACTURING COMPANY

P. O. Box 42 *"Serving Since 1892"* Coraopolis, Pa.

CHEMICALS YOU LIVE BY

Diamond Chlorine

Conveniently Located Chlorine Plants

Looking for a reliable chlorine producer that can back you up in emergencies? Call DIAMOND ALKALI.

We are equipped to give you fast service from five conveniently located plants as well as technical help from one of the world's greatest stores of chlorine know-how.

Call your nearest DIAMOND sales office or plant for regular or emergency shipments.

FREE! CHLORINE SAFE-HANDLING WALL CHART

DIAMOND ALKALI's years of know-how have been compressed into this chlorine safe-handling wall chart. Hang it where workers can read it. Copies free. Ask your DIAMOND sales office or write DIAMOND ALKALI COMPANY, 300 Union Commerce Building, Cleveland 14, Ohio.

DIAMOND CHEMICALS

Diamond Chemicals

CHLORINE PLANTS: Edgewood, Md. — Houston, Texas — Muscle Shoals, Ala., Painesville, Ohio — Pine Bluff, Ark.

SALES OFFICES: Cleveland, Cincinnati, Chicago, Houston, Memphis, New York, Philadelphia, Pittsburgh, St. Louis

motor to breathe with changing pressures and temperatures.

Standard models are available from 5 to 150 h.p., with discharge head 50 to 500 feet and 100 to 4,000 g.p.m. capacity.

Portable, Self-Propelled Earth Tamper

206

Jay Corporation, Columbus, Ohio, has developed a new vibrating portable earth tamper.

The Jay tamper, small enough to be carried in the trunk of a passenger car, is completely self-propelled and travels 64 to 70 ft. per minute while delivering 2,500 fifteen hundred lb. impacts. More pressure per inch than a 10 ton roller.

Powered by a 2½ hp Wisconsin air cooled engine, the tamper operates 8 hours on 2 gallons of gasoline. A special shock absorber, mounted between the handle and tamping chassis, combines with soft, sponge rubber handle grips to minimize vibration travel to the operator.

Quick-Opening Pipe Threader

207

Beaver Pipe Tools, Inc., Warren, Ohio, has developed a new Quick-Opening Quadra-type Threader for use with any power drive.

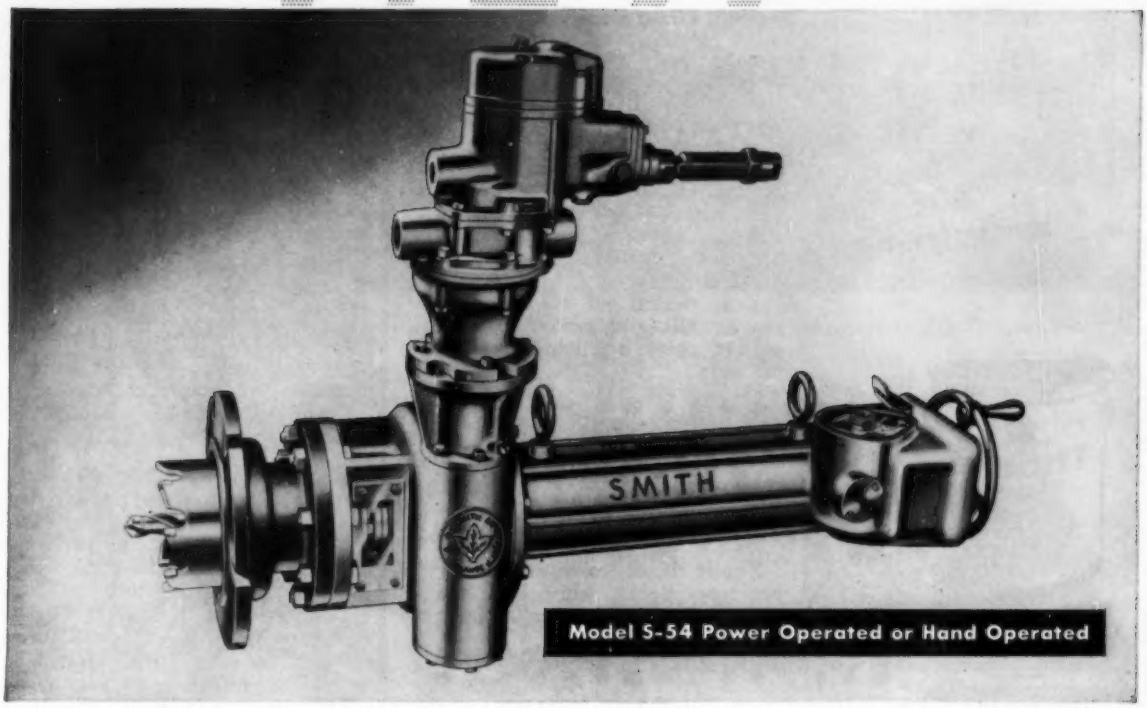
Called the Beaver "78," the new threader threads 1", 1¼", 1½" and 2" with only one set of full-width high speed dies . . . which is the same length as a perfect standard thread in the 1" to 2" range.

There is no lead screw to jam or reset. The user is able to set and reset dies instantly. A new guide design gives instant and perfect alignment without clamping to the work. These exclusive Beaver features insure perfect threads.

The new Beaver 78 has a quick-opening die throw-out. When the throw-out is opened, the dies retract. There's no need to back off

(Continued on page 92A)

NEW SMITH TAPPING MACHINES FOR TAPS 2″ THRU 12″ INCLUSIVE



The A. P. Smith Mfg. Company in 1896 introduced the first Tapping Machine for making connections sizes 2″ and larger to fluid and gas service piping under pressure. The *NEW* Smith S-54 Tapping Machine is the most modern, efficient and economical machine available. The S-54 Smith Tapping Machine is used with Tapping Sleeves, Hat Flanges, Saddles and Tapping Valves to make 2″ through 12″ connections under pressure to Cast Iron, Cement-Asbestos, Steel and Reinforced Concrete Pressure pipe. 1. AUTOMATIC FEED: Positive automatic feed insures correct drilling and tapping rate. Hand feed is provided to rapidly advance and withdraw Cutter. 2. TRAVEL INDICATOR: Chart attached to machine indicates travel required to complete tap. Travel is *AUTOMATICALLY* terminated when tap is completed. Cutter and shaft cannot overtravel. 3. COMPACT CONSTRUCTION: Telescopic shaft reduces overall length. 25″ travel is adequate for 2″ through 12″ taps to any size of pipe. 4. ENCLOSED CONSTRUCTION: Mechanism is housed in heat treated Aluminum Case filled with lubricant. Foreign matter cannot enter and damage mechanism. 5. STUFFING BOX AND PACKING GLAND: Accessible without disassembling machine. Equipped with Chevron packing. Line pressure cannot enter machine case. 6. RUGGED CONSTRUCTION: Extra large diameter telescopic shaft adds strength and rigidity. Timken radial—thrust bearings maintain alignment, reduce friction and wear. 7. DRIVING GEARS: Worm gearing operates in lubricant, torque is reduced to the minimum. 8. CUTTERS: Have replaceable Flat and Semi-V alternate teeth of High Speed Steel or Tungsten Carbide. 9. FLEXIBILITY: Hand Operated Machines can be converted to Power Operation by interchanging worm gearing. 10. AIR MOTOR: The motor attaches directly to the Power Operated Machine without Brackets, Holders, Adapters or Couplings. Bulletin sent on request.

52

FIRE HYDRANTS · VALVES · SINCE 1896

THE A.P. SMITH MFG. CO.

EAST ORANGE . NEW JERSEY

The THORO System of Masonry Protection

THOROCLEAR

Invisible Water Repellent

Ask your dealer about this powerful silicone water repellent developed by years of research by General Electric Company and now produced by us for your protection. *Ask for Circulars No. 30 and 31.*

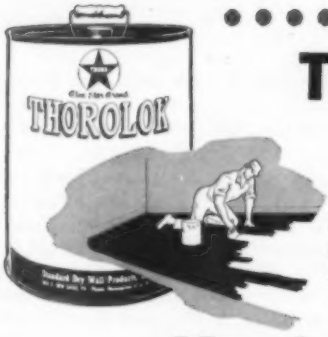
No change in color or texture of brick, limestone, sandstone, tile or stucco surfaces. Applied by brush or spray.

Keep water out of your masonry walls and protect interior plaster, paints and expensive furnishings.

THORITE

20 Minute Set Patching Compound

Repair those broken sills, steps, concrete floors, chimneys and other defective masonry! *Ask for circular No. 20.*



THOROLOK NO. 100

Use it for your basement or factory floors. New, with special alkali resistant pigments. *Ask for Color Card 32-C.*

Manufacturers of

WATERPLUG, THOROSEAL, QUICKSEAL

for all types of masonry protection!

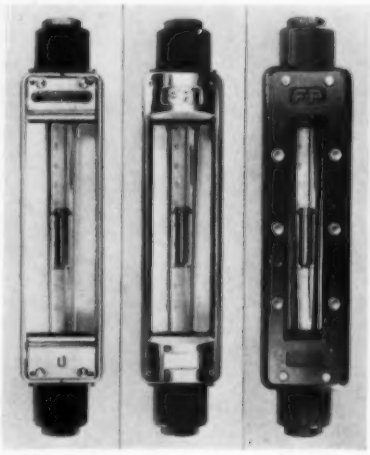
GET OUR PICTORIALLY DESCRIBED LITERATURE "HOW TO DO IT"

STANDARD DRY WALL PRODUCTS, INC.
NEW EAGLE, PENNSYLVANIA

over finished threads. When the handle is closed for the succeeding thread, the setting remains accurately in position for another perfect standard thread . . . time after time.

New Flowmeters Increase Visibility

208



Fischer & Porter Company, Hatboro, Pa., has introduced a new series of variable area flowmeters with simplified design features, sturdier construction, and 100 percent greater visibility of the metering tube.

Designated as the 1700 Series Flowrator Meter, it retains the inherent good features of the proven 700 series. The meters have the same overall dimensions, permitting a 1700 series meter to be substituted for a 700 series meter in any installation without costly pipe changes.

The improved design uses one basic frame which, with a quick change of covers, can be made into an enclosed or pressure-sealed meter. The enclosed meter is made of corrosion-resisting stainless steel. Fittings are offered in a variety of metals to meet varying corrosion conditions.

New Attachment Permits Earth Borer to Dig 100 Feet

209

Gen-A-Matic Corporation, Van Nuys, California, has developed a new milled slotted offset design on the basic shaft of its Super Hole-A-Matic earth boring machines that permits quick changes for earth-boring up to 100 feet or more.

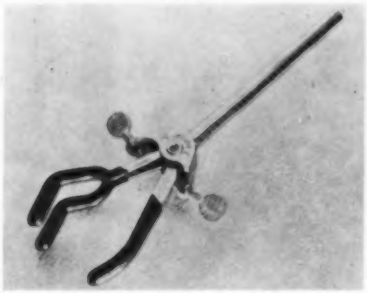
Called the Model BSCQ-20, this new shaft design enables the operator to disengage the motor from the shaft when the Super Hole-A-Matic is being used for deep earth

boring. Thus, new extensions are easily added for digging to greater depth, and removed when it is being withdrawn.

A one-man operated electric earth drill that bores at any angle, the Super Hole-A-Matic can also be used for tunneling, making it an excellent machine for preparing conduit and sewer lines.

New Gripping Jaws For Laboratory Clamps

210



Fisher Scientific Company, Pittsburgh, Pa., has announced a new development in their line of clamps and holders for laboratory use.

In the new line, the jaws of the clamps and holders are hot-dipped in a tough vinyl plastisol. This coating replaces the rubber "sleeves" formerly used, and becomes a permanent and integral part of the clamp with exceptional gripping surface, better heat resistance, and superior ageing qualities.

The company also announced that these clamps will still be available with fine-weave non-raveling asbestos jaws as well, for special purposes.

Table-Type Blast Cleaning Machine

211

Wheelabrator Corporation, Mishawaka, Ind., has available the Wheelabrator Plain Table, an airless blast cleaning machine particularly designed to handle a wide range of work.

One of the many applications of the machine is its use in reconditioning water and gas meters and it is ideal for flat or fragile work which requires careful handling.

A distinctive part of the machine is the plain circular work table, available in 6, 8, 10, or 12 inch diameters. It is positioned so that half is inside the blasting zone and half is outside. The operator continuously places the work to be cleaned on the part of the table that

(Continued on page 94A)

achieve POSITIVE ODOR CONTROL IN SEWAGE TREATMENT PLANTS with CIFON, N. Y.*

American Cities of every size are now overcoming ODOR problems with this new, economical and effective sanitation chemical.

In the treatment of raw sludge in storage tanks (1 gal. Cifon, N.Y. to 6000 gals. of raw sludge)—in the spray application at the vacuum filter exhaust and other vulnerable areas in the plant—and in the dosing of sand filter beds—CIFON, N.Y. has proven itself a positive odor-control agent. No special equipment or training of personnel required.

CIFON, N. Y. SERVES MUNICIPALITIES IN MANY WAYS

GARBAGE DISPOSAL DUMPS When sprayed on garbage dumps in a dilution of 1 gal. to 100 gallons of water CIFON, N.Y. will counteract the odor of garbage, will prevent the generation of undesirable odors due to decomposition of garbage and prevent the breeding of flies.

SEWER SANITATION CIFON, N.Y. will remove slime, bacteria and fats in plugged up sewers through its solvent action, and will aid in the control of disease producing and carrying organisms.

GENERAL SANITATION CIFON, N.Y. repels flies and mosquitoes and prevents mosquitoes from breeding in marshy lands . . . Used for dousing garbage trucks and garbage scows.

*CIFON, N.Y. *is an emulsifiable, sanitizing and deodorizing chemical—compatible with soap—contains no caustic, free chlorine or carbolic acid.*

FINE ORGANICS, INC.
211 EAST 19th STREET • NEW YORK 3, N. Y.

Mail handy coupon for complete information on how to solve ODOR problems in your city, quickly, efficiently, and economically. There is no obligation on your part.

FINE ORGANICS, INC., 211 E. 19th St. • Dept. 'WS' • New York 3, N. Y.

Gentlemen: Please send me information on CIFON, N.Y.

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

is outside, and as the table rotates, it carries the work into the blasting zone where it is struck by metallic abrasive thrown centrifugally from rotating, bladed wheels. Continuous rotation of the table brings the cleaned work back out again.

Valve Positioner

212

The Foxboro Company, Foxboro, Mass., has developed a highly accurate valve positioner, the Type C Vernier Valvactor. Designed for precise control action, the positioner overcomes friction and reduces line effects, speeding valve response to controller signal.

A simple motion balance device, the positioner receives a controller output signal at a spring-opposed bellows which governs a flapper-nozzle relationship. Back pressure in the nozzle circuit acts on a high capacity air relay to vary the supply pressure to the valve motor. Full pressure can be applied to the motor on a controller output change of less than 2 inches of water. As the valve stem moves to its correct position, a lever connected to the stem rotates the Valvactor shaft which, through a spring and ball arrangement, restores the flapper-nozzle relationship to a point of balance.

New Oiler For Pipe Threaders

213

The Ridge Tool Co., Elyria, Ohio, has developed a new oiler that is said to solve the problem of how to flood dies with cutting oil while threading pipe with hand die stocks, by muscle or power drive.

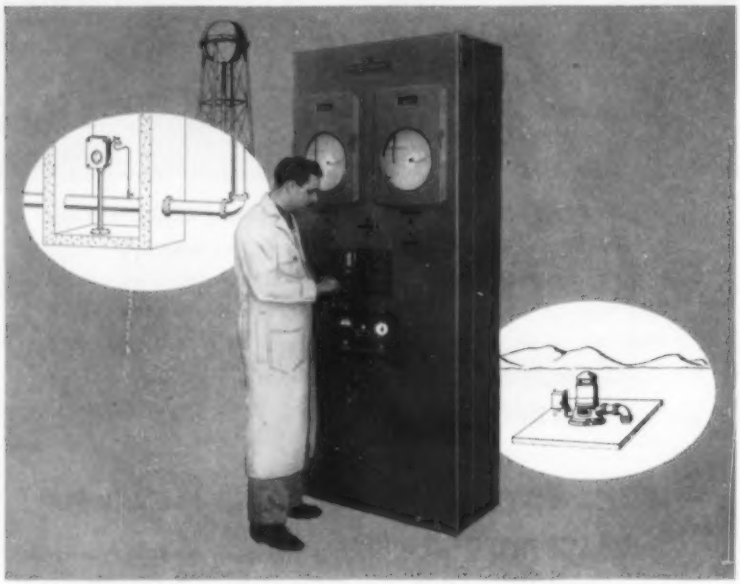
Called the Ridgoilr, it is easily portable, consisting of a removable 15 inch wide chip pan in an oil reservoir with carrying pail, from which a screened hose connects with a hand-operated oil pump-gun. Placed under the work, the device catches oil, chips and cut-offs, keeping floors clean, while allowing an endless stream of clean oil on dies, cooling and protecting them. More than 95% of the oil is saved and used over and over.

Telemetering Terminals

214

Radio Frequency Laboratories, Inc., Boonton, N. J., has announced the new Model 1025 Telemeter transmitter and the Model 1090 Telemeter receiver that will accurately and instantly telemeter quantities which can be converted into dc millivolts through use of a transducer or primary detector.

The transmitter converts the dc millivolts to an ac signal which in turn frequency modulates an included audio tone channel. The receiver converts the audio tones to dc millivolts which may then be used to operate a recorder or indicating instrument. The design of the included channeling



SYSTEM SUPERVISION IS SIMPLE AND ECONOMICAL WITH *Synchro-Scan**

ANOTHER B-I-F Blue Chip PRODUCT

Builders-Providence Synchro-Scan Supervisory Control gives you the economy of being able to operate remote equipment from a centralized control station — plus the extra economy of extreme simplicity: — basically right in its design, easy to operate, and easy to maintain.

May we tell you about Synchro-Scan Supervisory Control — the only control with the unique "building block" design. Send, today, for new Bulletin 240-M6. Builders-Providence, Inc., 350 Harris Avenue, Providence 1, Rhode Island.

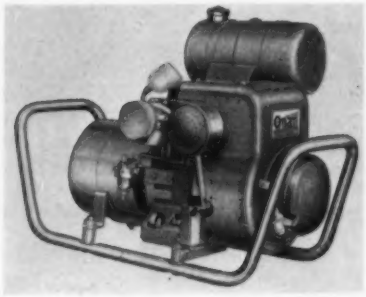
*Patent applied for

BUILDERS-PROVIDENCE
DIVISION OF B-I-F INDUSTRIES, INC.
BUILDERS IRON FOUNDRY • PROPORTIONEERS, INC. • OMEGA MACHINE CO.
BIF METERS FEEDERS CONTROLS

equipment assures accurate and reliable telemetering over all communication channels even when operating in the presence of noise and varying signal levels.

Lightweight Portable Electric Plant

215



D. W. Onan & Sons Inc., Minneapolis, Minn., has developed another lightweight new model in their AK series of portable electric generating plants.

The new model is an extremely lightweight 1500-watt, 60-cycle, A.C. electric plant. Offered in two versions: Model 105AK-1P, weighing 125 pounds, equipped with tubular aluminum carry frame as standard equipment; and Model 105AK-1M, weighs 130 pounds and is designed for stationary service but with carrying frame and 2-wheel dolly optional.

Ceilcrete Protects Concrete From Fluorides and Hydrofluoric Acid

216

The Ceilcote Company, Cleveland, Ohio, has announced the availability of an improved Ceilcrete "B" surface treating material which has been extensively tested and is now recommended for low-cost protection of concrete from Fluorides, Hydrofluoric Acid and Hydrofluoric Acid solutions.

A thermosetting plastic base surfacing, Ceilcrete "B" can be applied to floors, trenches, tank bases and other concrete structures. A minimum coating of ⅛-inch provides a monolithic membrane that is impervious to solutions containing Hydrofluoric Acid. The extreme density and stonelike hardness of Ceilcrete "B" makes it ideal for a wide variety of applications where resistance to abrasion, impact and constant immersion in acid solutions are important.

In many applications, Ceilcrete "B" has actually replaced brick. For example: Ceilcrete "B" has been successfully used for lining of pickling tank pits where Hydrofluoric Acid is being

(Continued on page 96A)

Sealing Compounds at Work!

PRESSTITE'S *cold applied 3-step sewer joint sealing system*

Prevents Overloading Sewage Disposal Plant

Extensive ground water infiltration can overload planned capacity of the disposal plant, resulting in serious trouble and expense. To prevent this, engineers specified Presstite's 3-step system to seal the recent 17-mile Decatur, Ill., sewer project.

Developed through extensive research, Presstite's economical proven system insures tighter, more dependable joints with three simple steps:

1. Presstite PRIMER . . . painted on bell and spigot ends before laying pipe, provides a better bond.

2. Plus Presstite ROPAX® . . . non-porous packing provides *additional* joint sealing material, forms solid seal impervious to passage of water.

3. Plus Presstite KALKTITE® . . . cold mixed, cold applied asphaltic cement completes sealing. Sets up under the most adverse conditions, forms dense, tough, flexible seal that *keeps water out!*

It's as simple as 1-2-3! You get tighter joints plus saving time and money with Presstite's 3-step system.

PRESSTITE SEALING COMPOUNDS

WRITE TODAY
for 20 page detailed catalog, samples and prices.

PRESSTITE ENGINEERING COMPANY
3780 Chouteau Avenue St. Louis 10, Mo.

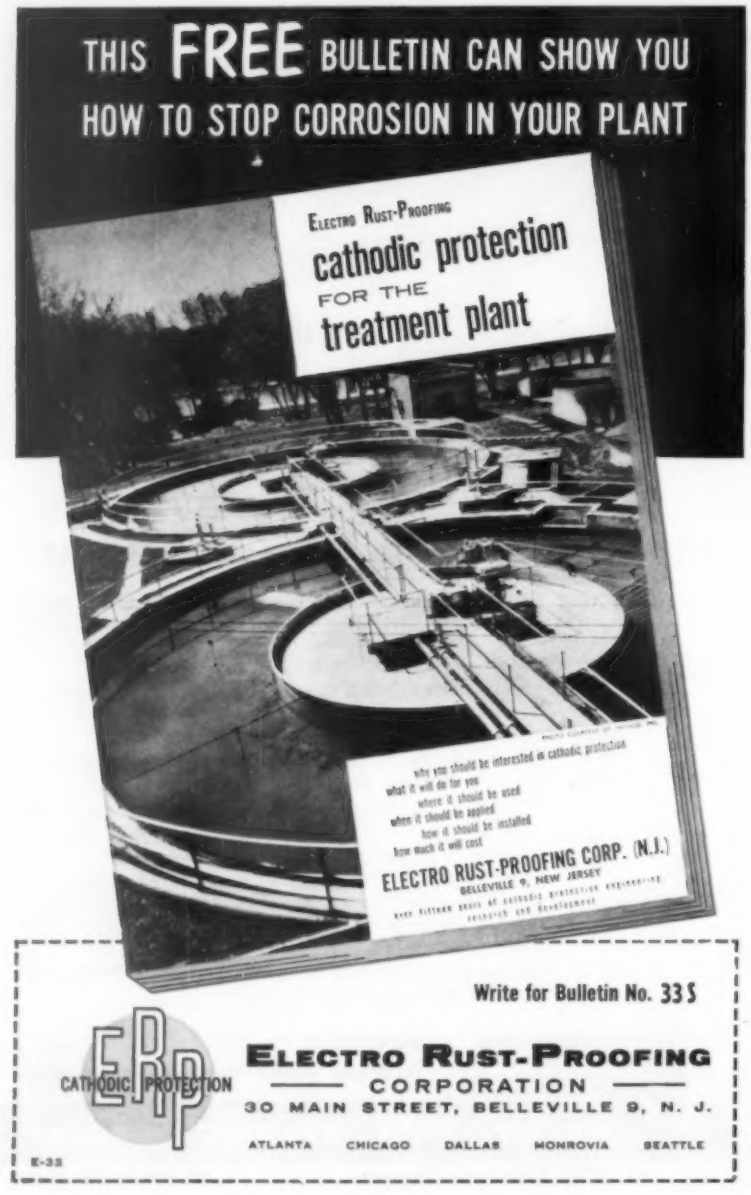
used. In this application walls, sides, and floor were coated with ⅛-inch of Ceilcrete "B" providing a monolithic membrane protecting the concrete.

Optional Air Lift Available With Graver Reactivator

217

Graver Water Conditioning Co., New York, N. Y., has announced the availability when required, of an optional air lift to replace the mechanical recirculator in its solids-contact clarifier, the Reactivator. In certain types of treatment, when technical factors so indicate, the mechanical impeller may be replaced by an air lift arrangement to provide recirculation. The resulting aeration, for example, is most useful in installations requiring iron removal.

Air, by means of an intake pipe, is brought in to the central uptake tube of the Reactivator where it is released. The upward flow of air bubbles carries recirculating precipitates up the tube mixing them with incoming raw water in much the same manner as the mechanical impeller. While use of the air lift is limited it has proven an important feature in situations calling for oxidation.


THIS FREE BULLETIN CAN SHOW YOU
HOW TO STOP CORROSION IN YOUR PLANT
ELECTRO RUST-PROOFING
cathodic protection
FOR THE
treatment plant
why you should be interested in cathodic protection
what it will do for you
where it should be used
when it should be applied
how it should be installed
how much it will cost
ELECTRO RUST-PROOFING CORP. (N.J.)
BELLEVILLE 9, NEW JERSEY
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ERP
CATHODIC PROTECTION
ELECTRO RUST-PROOFING
CORPORATION
30 MAIN STREET, BELLEVILLE 9, N. J.
ATLANTA CHICAGO DALLAS MONROVIA SEATTLE
E-33

Template For Piping Drawings

218

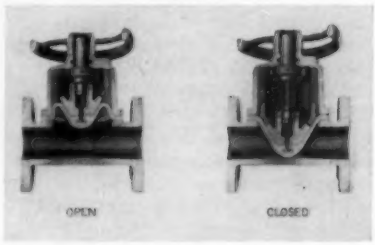
Dot-N-Dasher, Cresskill, N. J., has developed a template which enables a draftsman to draw dot and dash lines with a rapid stroke of a pencil or ball-point pen.

Produced by a professional engineer for making piping drawings, the template is applicable to any type of architectural or mechanical drawing where various broken-line combinations are desired. The template will produce six different lines: long dash, short dash, long dash and dot, short dash and dot, long dash and two dots, and short dash and two dots. The hardness of the pencil determines the density of the line.

Made of exceptionally strong and durable transparent plastic, the template is used by placing a straight edge on the desired stencil and quickly drawing the line.

Straightway Diaphragm Valve

219



Grinnell Company, Inc., Providence, R. I., has announced the Grinnell-Saunders Straightway diaphragm valve that offers the extra advantages of straight-through flow for handling viscous materials, fibrous slurries, sludges, semi-fluids and solids in suspension.

The Straightway feature offers: ability to handle viscous material without restriction or stoppage; minimum pressure drop; rodding or brushing without removing valve bonnet and without possible damage to body linings; and self-drainage when the pipe line is pitched sufficiently to drain the piping.

The Straightway valve retains all of the advantages of the conventional Grinnell-Saunders weir type diaphragm valve; positive closure even when handling gritty or fibrous material; isolation of bonnet from fluid stream; wide range of body and bonnet styles as well as body, lining and diaphragm materials; simple maintenance—only the diaphragm normally being subject to wear and then easily replaced — there being no packing glands, disc holder or metal-to-metal seat.

A fast digging rig, the jet trencher is also fast and easy to hook up and detach—only 90 seconds! Makes the ideal working partner to the Oliver OC-3 with loader or back filler attachment.

How the Oliver OC-3 tractor with fast-acting equipment multiplies work power

The OC-3 belies its small size with the big work it can do when equipped with the front end loader. Here it's doing fast cover-up job on sewerage plant project.

—saves cost on big sewer job!

Here, on this big North Carolina sewage plant project, you can see how this versatile Oliver OC-3 uses its rugged, compact design to make the most of digging, dozing and loading equipment.

With the new Oliver Jet Trencher, it's digging 5000 feet of ditch in hard clay...excavating for gasoline storage tanks and septic tanks. Powerful down pressure and smooth, responsive hydraulic control make fast work of these jobs.

Then, with the jet trencher quickly uncoupled and with counterweight added, the OC-3 moves on to speed up other work with its front end loader—fine grade foundation bottoms...back fill ditches...transport pumps, concrete and pipe from one location to another...move heavy equipment.

The OC-3 is a powerful, money-saving worker on any job. See how you can "tailor" the Oliver OC-3 tractor to your exact needs with its eight different attachments. See your Oliver Industrial distributor.

THE OLIVER CORPORATION

400 West Madison Street, Chicago 6, Illinois

OLIVER

a complete line of industrial wheel and crawler tractors and matched allied equipment

Skidding heavy concrete pipe into place is simple with the OC-3. Handy small size and unusual maneuverability plus sure-footed traction get jobs done fast.

Another job the OC-3 handled on this big sewer project. Toting concrete bucket shows bonus capacity of this compact, power-packed crawler.

W&SW

Manufacturers' News

Dorr-Oliver Inc. and E. Long Ltd. Combine Canadian Operations

Dorr-Oliver Incorporated, Stamford, Conn., has announced the integration of the Canadian operations of Dorr-Oliver with those of E. Long Limited of Orillia, Ontario. The new organization will be known as Dorr-Oliver-Long Limited.

Clarence R. Long, presently a Director of Dorr-Oliver Inc. and President of E. Long Ltd. will be the President of the enlarged organization. Headquarters will be located in Orillia, with the former Toronto office of Dorr-Oliver and the Vancouver office of E. Long operating as divisional sales offices.

The result of several months of careful study, the action is the culmination of an extremely close relationship between the companies over the years. Dorr-Oliver Inc. was formed on December 31, 1954, by the merger of Oliver United Filters Inc. of Oakland, Calif., with The Dorr Company of Stamford, Conn., and the associations of both former companies with the E. Long interests dates back many years. The Orillia shops of E. Long have manufactured Dorr equipment since 1911, Oliver equipment since 1930, and E. Long has, in addition, represented Oliver on a sales basis since 1940.

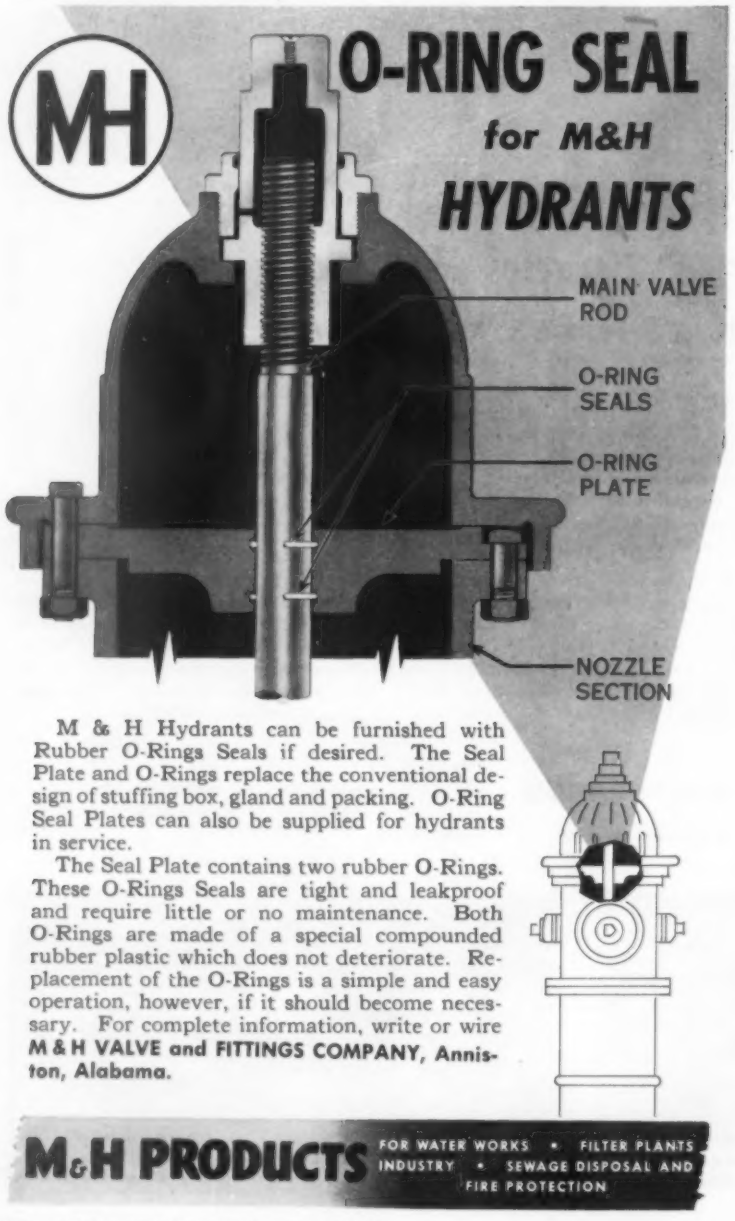
Foxboro Building New Instrument Training Center

The Foxboro Company, Foxboro, Mass., has announced that in view of industry's increased demand for trained instrument personnel, it is doubling the size of its Training and Education Center. Scheduled for completion early in 1956, the new building

will accommodate 46 trainees, nearly twice the number handled previously.

Plans call for two 20-student classrooms, two laboratories where bench instruction and service training can be given, an instrument demonstration room, a conference area, and enlarged quarters for the expanding teaching staff.

Completion of the new facilities will help reduce the customary waiting period for customers' men who enroll in the various courses of instruction. Nearly twice as many courses will be offered, these to include specialized training in electronic instruments and advanced forums for various industry groups, as well as



M & H Hydrants can be furnished with Rubber O-Rings Seals if desired. The Seal Plate and O-Rings replace the conventional design of stuffing box, gland and packing. O-Ring Seal Plates can also be supplied for hydrants in service.

The Seal Plate contains two rubber O-Rings. These O-Rings Seals are tight and leakproof and require little or no maintenance. Both O-Rings are made of a special compounded rubber plastic which does not deteriorate. Replacement of the O-Rings is a simple and easy operation, however, if it should become necessary. For complete information, write or wire **M & H VALVE and FITTINGS COMPANY, Anniston, Alabama.**

M&H PRODUCTS FOR WATER WORKS • FILTER PLANTS INDUSTRY • SEWAGE DISPOSAL AND FIRE PROTECTION

the standard three-week general courses which will cover all phases of instrument work.

O'Leary Retires From Pittsburgh-Des Moines

Pittsburgh-Des Moines Steel Company, Pittsburgh, Pa., has announced the retirement of John E. O'Leary, who has been general sales manager for the past twenty-six years. Widely known in the municipal water works and general construction fields, Mr. O'Leary has been associated with the company for forty-five years.

T. W. Fauntleroy has been named to succeed Mr. O'Leary as general sales manager. He has been with the company since the end of World War II. A graduate of Virginia Polytechnic Institute, Mr. Fauntleroy during World War II saw military service as an Air Force pilot.

Green Bay Foundry Agents For Pacific Flotation Separators

Green Bay Foundry & Machine Works, Green Bay, Wisconsin, manufacturers of the "North" rotary screens, have announced their appointment as exclusive Midwest agents for the Pacific Flotation Separators manufactured by Pacific Industrial Engineering, Inc., of Pasadena, California.

The company stated that with the addition of these separator units to the line of "North" screens they will now be able to offer a complete package treatment unit.

Gamon Meter Adds Two Salesmen

The Gamon Meter Division of Worthington Corporation, Newark, N. J., has announced the addition of two new salesmen to its sales organization.

H. J. Stolz, who will be headquartered at the San Francisco District Office and will cover the San Francisco area, has rejoined Worthington after an absence of eleven years, during which time he was in business for

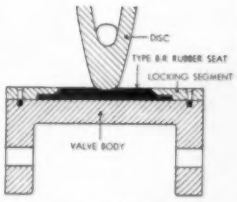
(Continued on page 100A)

Be Sure of

DROP-TIGHT CLOSURE

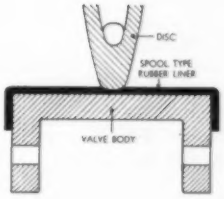
Valve with *Rubber Seat*

In this Rockwell butterfly valve the stainless steel edge of valve disc presses at 90° into thick, precision-molded Type B-R rubber seat, which is clamped in position by removable metal locking segments. Shaft of stainless steel (or other metal). Bearings—lifetime, heavy duty graphite-lubricated, sleeve type. No corrosion or contamination. Meets AWWA specifications for 25, 50 and 125 p.s.i. butterfly valves.



Valve *Rubber-Lined*

Valve with rubber spool liner—natural or synthetic, hard or soft—vulcanized and cemented to valve body. Preferred where fluid may affect cast iron or fabricated steel construction.



Other Advantages

- Minimum Restriction to Flow
- Self-Cleaning—No Debris-Collecting Pockets
- Compact • Lighter Weight
- Require Less Space
- Easier to Install

W. S. Rockwell Butterfly Valves are made in sizes from 4" to 144"; cast iron, fabricated steel or alloy construction. Furnished with any manual or automatic operator.

W. S. ROCKWELL COMPANY

ROCKWELL SINCE 1888 BUILT

BUTTERFLY VALVES • SLIDE VALVES • AUTOMATIC VALVES

2826 ELIOT STREET • FAIRFIELD, CONN.

Sales Representatives in Principal Cities

himself. Mr. Stolz originally joined Worthington Corporation at the Buffalo Works in 1936 and was later transferred to the Los Angeles district office territory.

Representing Worthington-Gamon Meter Division in the Los Angeles area will be E. A. Bagnell, a resident of San Diego, California, who was associated with the City of San Diego for nine years prior to his joining Worthington. While with the City of San Diego, Mr. Bagnell served in the Purchasing Department and Water Department, re-designing the meter shop and work loads for the city and installing a preventive maintenance program for the Water Department. Prior to his affiliation with the City of San Diego, Mr. Bagnell served eight years in the United States Marine Corps.

Chicago Bridge Expands San Francisco, Tulsa Offices

Enlarged sales offices in San Francisco, California, and Tulsa, Oklahoma, are announced by Chicago Bridge & Iron Company.

The new address of the San Francisco office is 100 Bush Street, San Francisco, 4. New location for the Tulsa office is Dowell Building, 1645 East 21st Street, Tulsa, 14.

Pittsburgh Coke Reassigns Sales Representatives

The Protective Coatings Division of Pittsburgh Coke & Chemical Company, Pittsburgh, Pa., has announced two new sales assignments for its pipeline enamels and cold coatings.

J. E. Himmelrich has been reassigned from Pittsburgh to the Tulsa office, and will represent the division in the states of Oklahoma, Kansas, Nebraska and Colorado.

M. P. Ellis has moved to the company's Pittsburgh office and will cover the territory formerly assigned to Mr. Himmelrich, consisting of Ohio, Kentucky, West Virginia and Western Pennsylvania.

Doonan Joins Hammond Iron Works

Hammond Iron Works Company, New York, N. Y., has announced the appointment of Robert A. Doonan as sales engineer attached to the Birmingham, Alabama, District Sales office.

Doonan, a resident of Birmingham, holds a B.S. degree in Chemical Engineering from Northeastern University and has ten years' experience in the design and operation of chemical and petrochemical processing plants throughout the country. He has been sales engineering representative for a number of leading research and manufacturing companies.

Magner Joins F. & P. Municipal Division

Fischer & Porter Company, Hatboro, Pa., has announced that Jerry L. Magner has been appointed an application engineer in the Municipal division.

Magner formerly was a project engineer at Infilco, Inc., Tucson, Ariz., where he worked on the design and engineering of equipment and complete plants for municipal water treatment.

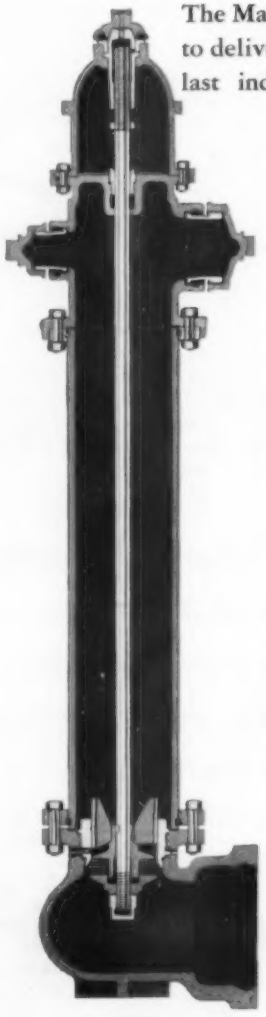
A native of Greensburg, Pa., he was graduated from Carnegie Institute of Technology, Pittsburgh, Pa., in 1952 with a Bachelor of Science degree.

Executive Sales Changes At Hardinge

Hardinge Co., Inc., York, Pa., has announced the following changes in its sales department:

Gilbert F. Metz, formerly Eastern District Manager and Supervisor of Sales Promotion for the company,

Reduce Wear, Save with Mathews



The Mathews Flange Barrel Hydrant is designed to deliver every available gallon of water and to last indefinitely with minimum maintenance.

CHECK THESE IMPORTANT FEATURES

The Flange Barrel

The swivel flange at the base of the nozzle section permits nozzles to be faced toward any point in the complete circle. Saves time on original installation and on replacements.

On broken hydrants, top cap and nozzle sections can usually be salvaged, thus reducing accident costs.

The Stuffing Box Plate

Cast integral with the nozzle section, the plate keeps water and sediment away from the operating thread. Hydrant remains operable in any weather. Wear on the operating thread is largely eliminated.

Made by

Available with mechanical joint pipe connections.

has retired after 36 years with the company. His address for the present will be Farquhar Estates, York, Pa., although he plans, ultimately to reside at Vero Beach, Florida.

H. Sidney Downes has been named Eastern District Manager, replacing G. F. Metz. His territory includes the western portions of New York and Pennsylvania, all of Ohio and most of Kentucky.

James K. Towers, formerly Southeastern District Manager for the company, has retired after 36 years service. He has been replaced by Clarence B. Brown, Jr., and his territory includes southern New Jersey, eastern Pennsylvania, eastern Maryland, Delaware, Virginia, the Carolinas, Tennessee, Alabama, Mississippi and most of Louisiana.

Ellsworth B. Doelp has been named District Manager for the company's Central Territory. He is in charge of all sales of Hardinge equipment in the states of Illinois, Iowa and portions of Texas, Wisconsin, Michigan and Kentucky.

General Chemical To Build Aluminum Sulfate Plant

General Chemical Division, Allied Chemical & Dye Corporation, New York, N. Y., has announced plans to start immediate construction of a plant for manufacture of liquid aluminum sulfate at Hopewell, Virginia.

The company stated that the plant is expected to be in operation early in 1956. Its output will go primarily to municipal and industrial water and sewage treatment plants, and to pulp and paper mills in the area, for which the chemical is a principal process material.

General Chemical is one of the country's major producers of both dry and liquid aluminum sulfate. With the addition of the Hopewell unit, it will have 24 such plants from coast to coast. Its other alum-producing facilities in the South are located at Atlanta, Macon and Savannah, Georgia; Jacksonville, Florida; and Monroe and New Orleans, Louisiana.

Neptune Opens West Coast Testing And Repair Shops

Neptune Meter Co., New York, N. Y., has announced that facilities for testing and repairing the largest meters for measuring water or other liquids used by industry on the Pacific Coast have been installed in the new Company headquarters in Los Angeles.

Located at 5540 East Harbor St., in East Los Angeles, the new building provides 25,000 square feet for testing, repairing and warehousing of residential, commercial and industrial meters.

In addition to providing space for keeping a large stock on hand for prompt servicing of public and private water supply systems, the new building has a large parts department to service water utilities which maintain their own testing and repair shops.

Hays Corporation Announces Reorganization

The Hays Corporation, Michigan City, Indiana, has announced a reorganization of the company. The new organization will include a Hays division and a Metrotype division.

Donald R. Schoen, vice president of manufacturing for Hays, has been named manager of the Hays division, and Robert E. Navin, also a vice pres-

(Continued on page 102A)

Time and Money Flange Barrel Hydrant

Breakable Flange and Stem Coupling

Optional feature furnished at extra cost. Specially designed flange in the standpipe just above ground level and a frangible coupling in the hydrant stem are designed to snap when struck a blow heavy enough to break the hydrant. Both can be replaced quickly *and without excavating*, while hydrant head, standpipe and stem remain undamaged.

ADDITIONAL ADVANTAGES

Two-way heads can be replaced with steamer and two-way heads without shutting off water.

Shield operating nut assures protection for the revolving nut from sleet, snow or dust.

An extension piece may be inserted between hydrant head and barrel or between barrel and elbow.

R. D. WOOD COMPANY

Public Ledger Building, Independence Square, Philadelphia 5, Pa.

Manufacturers of "Sand-Spun" Pipe (centrifugally cast in sand molds) and R. D. Wood Gate Valves

ident at Hays, in charge of engineering, was named manager of the Metrotype division.

Graver Opens New Sales-Service Office

Graver Water Conditioning Co., New York, N. Y., has announced the opening of a new sales-service office to serve Detroit, the surrounding industrial area, and all of Michigan.

According to the company, an important feature of the new office is the provision of both sales and service personnel. This is designed to provide Graver's customers not only with the direct contact of a technically trained sales engineer but with a permanent follow-up engineering service in the installation, start-up and operation of Graver equipment. Office location will be at 17590 James Couzens Highway, Detroit. Telephone is UNiversity 4-7013.

Allis-Chalmers Promotes Becker

Allis-Chalmers Manufacturing Company, Industries Group, Milwaukee, Wis., has announced that John W. Becker, a sales representative in the Syracuse district since 1951, has been named manager of the district.

Becker has been with Allis-Chalmers since his graduation in 1948 as an electrical engineer from the University of Nebraska. At Syracuse he succeeds A. J. Mestier, Jr., recently named manager of the Detroit district.

Willetts Named Sales Manager Of Sheppard Diesel

Sheppard Diesels, Hanover, Pa., has announced the appointment of Russell L. Willetts to the position of sales manager, Engine Division.

A student of Drexel Institute of Technology, Willetts served with the U. S. Navy during World War II as an inspector of Internal Combustion Engines. Prior to joining the Sheppard organization, he was a member of the engineering staff of Baldwin Locomotives.

No newcomer to the Sheppard Diesel organization, Willetts has been with the company for 8½ years; serving in the capacity of Service Manager for 7 years and as Manager of the Sheppard Diesel Original Equipment Division for the past 1½ years.

A. O. Smith Promotes Asher

A. O. Smith Corporation, Milwaukee, Wisconsin, has announced that W. M. Asher has been named sales manager for hydraulic products at the company's Pacific Coast Works. For the last three years, Mr. Asher has been sales manager for the company in Houston, Tex.

Hersey Appoints New Board Members

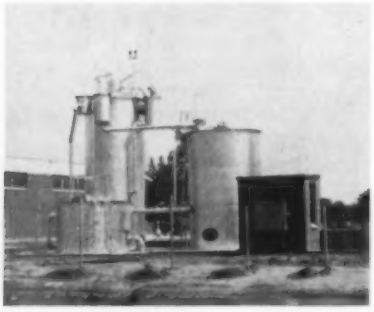
Hersey Manufacturing Co., South Boston, Mass., has announced the following recent additions to the Board of Directors: Frederick S. Blackall, Jr., President and Treasurer of The Taft-Peirce Mfg. Co., Woonsocket, R. I.; and Frederick W. Greer, Chairman of the Board of the J. W. Greer Co., Wilmington, Mass.

M-H Industrial Division Promotes Three

Minneapolis-Honeywell Regulator Company, Philadelphia, Pa., has announced the promotion of three field sales engineers to key Industrial Division posts.

James W. Hughes has been named regional industrial sales manager for the company's Midwest region with headquarters in Chicago. Raymond A. Zack will become industrial sales manager in the company's Hammond, Ind.,

AN ALL STEEL Waste Treatment Plant



The tank at the left is a Spiragester, the tank to the right is a high rate filter, and the short tank in the foreground is a non-mechanized hoppered bottom final Spiraflo Clarifier. The plant handles the wastes from an ice cream manufacturing plant.

Write for New
Spiragester Bulletin No. 135

LAKESIDE ENGINEERING CORPORATION
222 West Adams Street • Chicago 6, Ill.

These are Impressive Performers

NON-CLOG SIZES UP TO 8"
HEAVY and LIGHT DUTY
Type KS Aurora Heavy Duty Non-Clog Sump Pump
Every detail of Aurora Vertical Sump Pumps has been selected or developed with the definite purpose of achieving lasting, trouble-free and efficient operation.
Write for Bulletin 104
AURORA Always PUMPS

DISTRIBUTORS IN PRINCIPAL CITIES

AURORA® PUMP DIVISION
THE NEW YORK AIR BRAKE COMPANY
68 LOUCKS STREET • AURORA • ILLINOIS

branch office, and Paul R. Sharadin has been assigned to the new position of regional application engineer for the Southwestern region with headquarters in Dallas, Tex.

According to O. B. Wilson, general sales manager of the Industrial Division, the new assignments are part of the company's planned expansion to keep pace with technological advances in industrial instrumentation and the rapidly increasing use of automatic control equipment in industry.

Rockwell Opens Denver Branch

Rockwell Manufacturing Company's Meter and Valve Division, Pittsburgh, Pa., has opened a branch office at 1421 Mile High Center Building, Denver, Colorado, and has named Orville Cochran branch manager.

Mr. Cochran, a native of Livingston County, Missouri, has been a sales engineer for Rockwell in the Rocky Mountain territory for more than 25 years. He joined the company in 1922, spending eight years in the Kansas City district office.

He has lived in Denver for the past nine years and currently resides at 950 Milwaukee Way.

Hagan Corp. To Build New Plant

Hagan Corporation, Pittsburgh, Pa., has announced that it will build a $1 million chemical processing plant at Rockwood, Michigan.

Scheduled for completion in the fall of 1956, the new plant will process and package various Calgon products used for conditioning water for household, commercial, industrial and municipal purposes.

Hagan manufactures instrument, control and water conditioning equipment and materials at plants in Pittsburgh, Ellwood City, Pa., and at Orrville, Ohio.

Cosby Joins Presstite Engineering

Presstite Engineering Company, St. Louis, Mo., has announced that Mr. Charles E. Cosby has joined the staff of the company as executive assistant to the Vice President in Charge of Sales.

Mr. Cosby, who prior to his association with Presstite, served as Divisional Sales Manager of Mallinckodt Chemical Works in St. Louis, has broad marketing and sales experience. He has a M.B.A. degree from Harvard Business School in Sales Management.

Davison Chemical Increases Output of Hydrofluosilicic Acid

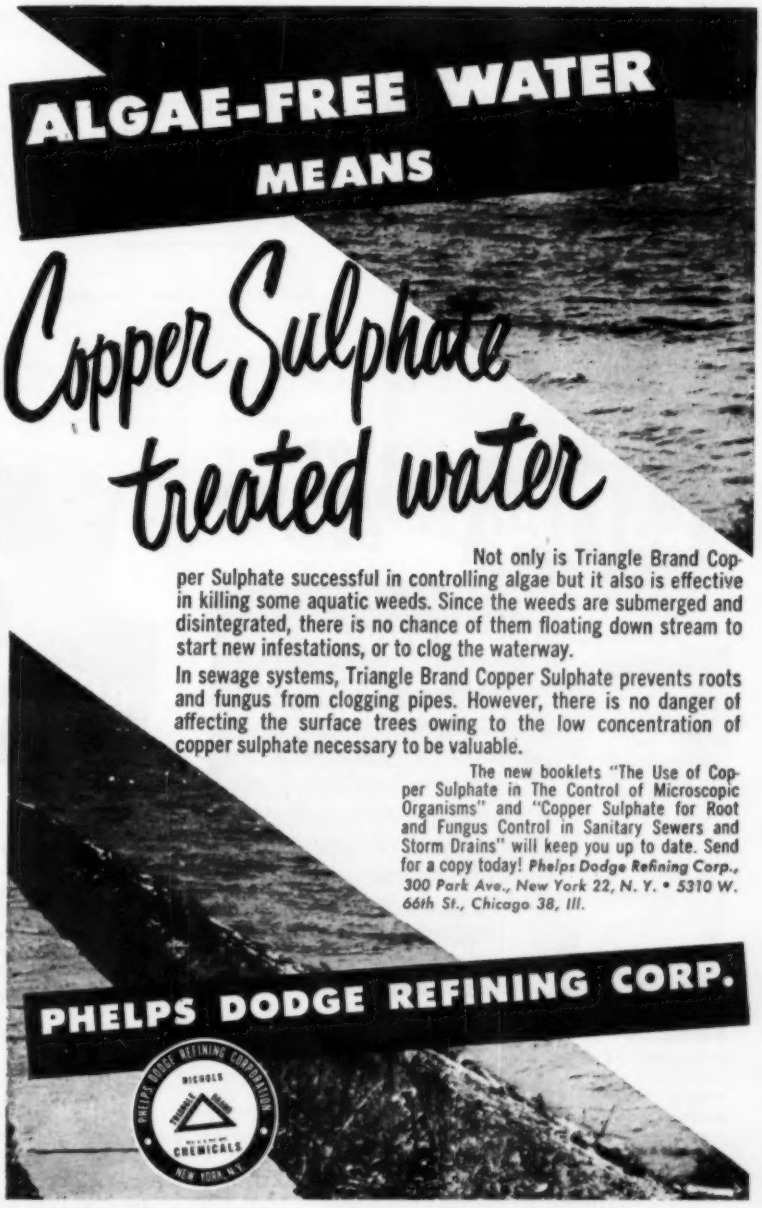
Davison Chemical Company Division of W. R. Grace & Co., Baltimore, Md., has announced that in response to a growing demand for hydrofluosilicic acid for water fluoridation, the company has completed installation of new production facilities at plants in Lansing, Mich., Columbus, Ohio, and Nashville, Tenn.

These new facilities will bring Davison's total capacity for the acid to more than 14,000 tons annually.

Pleuger Pumps Appoints Sales Manager

Pleuger Submersible Pumps, Inc., Lancaster, Pa., has announced the appointment of Alfred B. Krechtler as Eastern Sales Manager. He will direct Pleuger sales efforts east of the Mississippi River.

Krechtler, a Mechanical Engineering graduate of the University of California, has been active in the pump industry since 1940, having served in executive pump sales capacities throughout the Pacific Coast and Northeastern territories.


ALGAE-FREE WATER
MEANS
Copper Sulphate
treated water
Not only is Triangle Brand Copper Sulphate successful in controlling algae but it also is effective in killing some aquatic weeds. Since the weeds are submerged and disintegrated, there is no chance of them floating down stream to start new infestations, or to clog the waterway.
In sewage systems, Triangle Brand Copper Sulphate prevents roots and fungus from clogging pipes. However, there is no danger of affecting the surface trees owing to the low concentration of copper sulphate necessary to be valuable.
The new booklets "The Use of Copper Sulphate in The Control of Microscopic Organisms" and "Copper Sulphate for Root and Fungus Control in Sanitary Sewers and Storm Drains" will keep you up to date. Send for a copy today! Phelps Dodge Refining Corp., 300 Park Ave., New York 22, N. Y. • 5310 W. 66th St., Chicago 38, Ill.
PHELPS DODGE REFINING CORP.
PHELPS DODGE REFINING CORPORATION
PICQUES
CHEMICALS
NEW YORK, N.Y.

• If interested in equipment or literature mentioned below, mail a Reader Service Card with your name, address, and item key number.

W&SW

New Literature

Pneumatic Regulators

220

Conoflow Corporation, Philadelphia, Pa., has just issued a bulletin on **Pneumatic Regulators.**

This 8-page booklet lists a complete line of precision-made pneumatic regulator equipment including: filter-regulator combinations, filters and regulators, relays, purge assemblies and control panels. This descriptive, indexed bulletin is well illustrated with cross section and dimension drawings, and gives typical applications of use.

Handbook on pH and Chlorine Control

221

The W. A. Taylor Company, Baltimore, Md., has just released the 25th Anniversary edition (12th) of its handbook, "**Modern pH and Chlorine Control,**" incorporating the theory and practice of colorimetric analysis. The pocket-size, 100-page booklet serves as a handy reference for quantitative determinations of pH, chlorine, bromine, fluoride, phosphate, nitrate, hardness, and other special tests. Slide comparators and complete test kits are illustrated and detailed methods are discussed.

Many of these methods have particular application in municipal water and sewage plants. Among these is a new Syndet Comparator for checking sewage for an excess of synthetic detergents which cause foaming and restrict sedimentation.

R-S Butterfly Valves Catalog

222

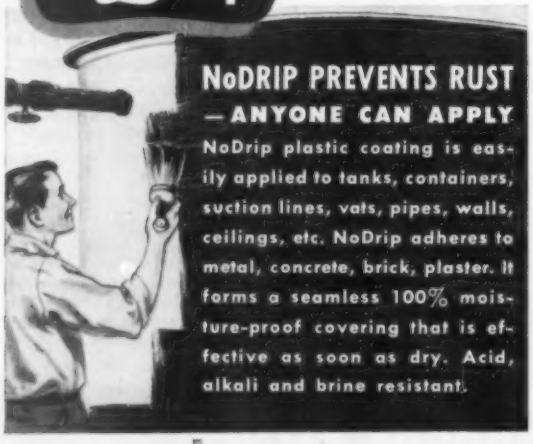
The S. Morgan Smith Company, York, Pa., has published the first half of what will be the most complete catalog of **Butterfly Valves** for industry that has ever been compiled.

The new catalog, in loose-leaf form for ease in keeping up-to-date, contains several innovations for publications of its kind:

It will include a section on basic engineering data which is complete enough to permit the user to accurately size the valves needed. These can be selected from the complete R-S Butterfly Valve line in the 15- to 300-lb. range. A complete description of each valve, with specifications, layout drawings and dimensions of standard valves in each pressure rating, is given.

The catalog also contains sections on special metals and modifications available for extreme operating conditions, data on standard valve operators and positioners, and is coded to identify the R-S Standard-stock valves (valves found to be most commonly in demand and carried in stock); standard valves (valves already engineered and available on short notice but not carried in stock), and special valves which of neces-

NoDrip® ...STOPS CONDENSATION DRIP



NoDRIP PREVENTS RUST —ANYONE CAN APPLY

NoDrip plastic coating is easily applied to tanks, containers, suction lines, vats, pipes, walls, ceilings, etc. NoDrip adheres to metal, concrete, brick, plaster. It forms a seamless 100% moisture-proof covering that is effective as soon as dry. Acid, alkali and brine resistant.

FREE... Interesting 32-page Handbook shows what NoDrip is and what it does. SEND COUPON TODAY

SEND NoDRIP HANDBOOK

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J. W. MORTELL CO. • 599-B BURCH ST. • KANKAKEE, ILL.

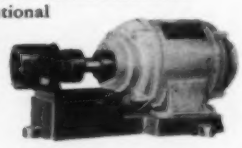
TECHNICAL COATINGS SINCE 1895

ACE-JABSCO ACID PUMP

OUT-LASTS OUT-PUMPS anything in its price class

This little Jabsco, neoprene-impeller, self priming pump made of Ace hard rubber for handling acids and alkalis, delivers more liquid within its pressure range than any other pump in its weight, size and price class. From 15 gpm at 22 ft. head to 5 gpm at 72 ft. head. Self lubricated flexible impeller outlasts conventional metal rotors. Easy to service.

Ace hard rubber centrifugal and gear pumps also available. Write today for free Bulletin 97-A.



ACE rubber and plastic processing equipment • SINCE 1852

AMERICAN HARD RUBBER COMPANY, 93 Worth St., New York 13, N. Y.

I'm Rugged!

I'm Cast Iron Pipe and I'm designed to perform rugged service for many, many years. I can take it for centuries at a time and still be in tip top shape, and the best recommendation I have is my past performance. Check my record . . . Efficient and economical service for hundreds of years . . . I'm a rugged individual ready to serve.

Alabama's Super De Lavaud Cast Iron Pipe . . . sizes of 3" to 24" in modern long lengths . . . Bell and Spigot, Roll-on-Joint, and Mechanical Joint and flanged.

We invite inquiries to our nearest sales office—

122 So. Michigan Avenue
Chicago 3, Ill.

350 Fifth Avenue
New York 1, New York

General Sales Offices

ALABAMA PIPE COMPANY

ANNISTON, ALABAMA

sity must be built to order for specific customer requirements.

The catalog also contains registrations and transfer cards, to be filled out by the recipient and, if the occasion demands, by the person who succeeds the original catalog recipient. This provides assurance that supplementary catalog data and spec sheets are received by the man currently using the catalog.

Steel Water Pipe

223

The Steel Plate Fabricators Assn., Chicago, Ill., has released a 38-page brochure entitled **"Wherever Water Flows Steel Pipes It Best."**

Profusely illustrated, the brochure details: the history of steel pipe; how steel pipe is manufactured; advantages of steel pipe; ductility and adaptability; installation advantages of steel pipe; field joints; protective linings and coatings; and a complete listing of the American Water Works Association specifications. A bibliography on the uses of steel pipe also is included.

Low-Cost Volumetric Chlorine Gas Feeder

224

Builders-Providence, Inc., Providence, R. I., has just released a 4-page bulletin describing a low-cost **Volumetric Chlorine Gas Feeder,** equipped with automatic safety features, and combining the qualities of accuracy and dependability.

Informative sections on the operation, description, methods of control, safety features, plus photographs and diagrams in the bulletin, describe the Builders Model EVS Chlorinizer. Simple in principle and attractive in appearance, the chlorinizer controls and meters gas under vacuum, producing and delivering chlorine-water solution to the point of application.

Rubber Lining Catalog

225

Manhattan Rubber Division, Raybestos-Manhattan, Inc., Passaic, N. J., has just published a new catalog on **Manhattan Acid-Proof Rubber Linings.**

The catalog discusses corrosion, abrasion, and contamination resistant rubber linings for tanks, pipe, valves, and similar storage and process equipment. It is generously illustrated and contains

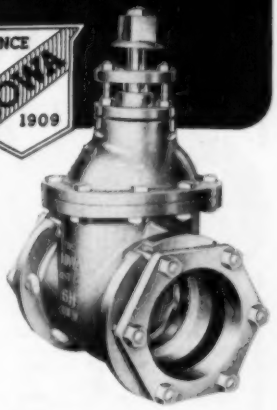
(Continued on page 106A)

IN EVERY WAY A SOUND CHOICE . . .

Specify IOWA for...

Gate Valves
Tapping Sleeves and Valves
Check Valves
Indicator Post Valves
Square Bottom Valves
Hydraulic Valves Motor Operated
Shear Gates
Fire Hydrants
Mud Valves
Flap Valves
Sluice Gates
Floor Stands
Valve Accessories

SINCE IOWA 1909



We manufacture complete equipment for water and sewage flow control in Filtration Plants, Sewage Disposal Plants and Pumping Stations. Specify Iowa and let us solve your problems.

IOWA VALVE COMPANY

OSKALOOSA, IOWA
A subsidiary of James B. Clow & Sons

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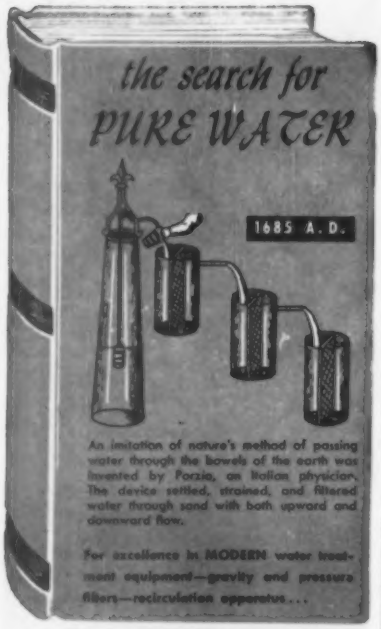
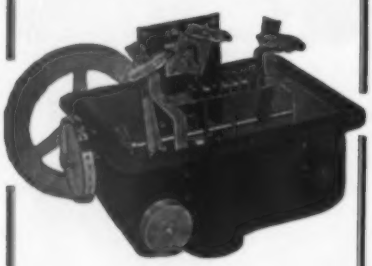

the search for
PURE WATER
1685 A. D.
An imitation of nature's method of passing water through the bowels of the earth was invented by Porzio, an Italian physician. The device settled, strained, and filtered water through sand with both upward and downward flow.
For excellence in MODERN water treatment equipment—gravity and pressure filters—recirculation apparatus...

MECHANICAL EQUIPMENT BY ROBERTS FILTER MFG. CO. DARBY, PENNA.

ROBERTS FILTER MFG. CO.
607 Columbia Ave.
Darby, Pa.

ROTO-TROL



RF-2

WITH ALTO-TROL

This 2-pump RF-2 Roto-Trol assures equal use and wear of both pumps. Each pump is operated on alternate starting cycles. The RF-2 operates both pumps together, when required. RF-2 installations give dependable service year after year, with the minimum of attention.

Write for full data

WATER LEVEL CONTROLS DIVISION
HEALY-RUFF COMPANY
783 HAMPDEN AVE., ST. PAUL 4, MINN.

many useful charts, tables and diagrams, along with specifications and suggestions covering tanks for several industries.

Welded Steel Pipe

226

Armco Drainage & Metal Products, Inc., Middletown, Ohio, has just published a bulletin that describes and illustrates the advantages of **Welded Steel Pipe** for factory piping, process piping, water supply, sewage disposal, foundation piling and other uses. Eleven advantages are listed and dimensional data and properties given. Also included are data on pressure design.

Rotary Distributor

227

The General Filter Company, Ames, Iowa, has just published a bulletin on the **"Gard" Rotary Distributor** for trickling filters.

The 4-page, 2-color bulletin states that the "Gard" distributor offers the following exclusive features: gravity reactors with nonclogging openings; self-aligning master bearing secured above water level; and nonseal design that eliminates mercury or oil seals completely.

New Trencher

228

The Earth Equipment Corp., Los Angeles, Calif., has published a new booklet pointing out that the new **Everett Trencher** has been specifically designed for use on the new Massey-Harris Ferguson 35 tractors or the new series 600 and 800 Ford tractors.

The profusely illustrated 4-page booklet describes in detail the many engineering features of the new trencher. Design improvements include: V-belt power drive with V-belt safety features; easy-to-get-at engaging and disengaging controls; built-in rock guard; and single-wheel design for faster penetration.

Precision Drive For Adjustable Speed Applications

229

Electric Machinery Mfg. Co., Minneapolis, Minn., has just published a full-color brochure that illustrates the new **"Ampli-Speed Magnetic Drive,** which provides precise, adjustable-speed power for a wide range of applications. The 4-page brochure explains use of the drive for both fan-type and constant torque loads.

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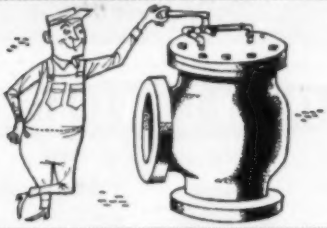

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trated clearly. Pictorial drawings show the relationship of the drive to its Magnetic Amplifier Control, the driving motor and driven load. The drive, it is pointed out, can be installed between an existing motor and load, or as an integral part of new machinery.

Electric Motors

230

Howell Electric Motors Co., Howell, Mich., has released a 16-page, full-color catalog that explains how the new **Series 100 Howell Motors** are smaller, lighter and cooler running.

The explaining is done by means of cut-away illustrations and diagrams along with short, incisive descriptions that show the advances in design that have been built into these new rerated motors. Both totally enclosed fan-cooled and open drip-proof types of integral horsepower motors are detailed, with other enclosures and mounting variations covered.

Weir And Flume Meters

231

Penn Instruments, Division of Burgess Manning Co., Philadelphia, Pa., has released a catalog on **Penn Float Operated Weir and Flume Meters.**

This attractive catalog discusses in detail the electric form of transmission that is somewhat different from the time impulse system. It states that by means of the reactance coil null balance system of electric transmission it is possible to obtain a chart record wherein the pen traces a continuous line which reflects the slightest movement of the float without the presence of "steps" encountered when the time impulse system is used.

Also discussed and illustrated are the various components and accessories available for use with other types of transmission systems.

Grating And Stair Treads

232

Klemp Metal Grating Corp., Chicago, Ill., has just published an illustrated report on the usage of **Steel, Aluminum and Stainless Grating and Stair Treads.**

The report, in brochure form, discusses the various types of electro-forged welded grating, as well as offering dimensional sketches and data on riveted grating.

A detailed safe load table with

(Continued on page 108A)

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There are, of course, good reasons why the Leopold Glazed Tile Filter Bottom is getting more popular every day. In this design, laterals and distributing blocks are combined in one permanent unit that insures equal distribution and uniform filtration. The individual blocks are made of de-aired fire clay, vitrified and salt glazed. They resist corrosion, are not subject to tuberculation, won't absorb any detrimental amount of water, are impervious to acids and alkalis, and will last indefinitely.

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conversion factors, panel width constant chart, and data on the standard widths and types of steel stair treads most frequently used, are recorded in the brochure. Also discussed is an illustrated series on the various types of anchors suggested for grating installations.

Agitator For Compound Melting Furnaces

233

Hauck Manufacturing Co., Brooklyn, N. Y., has released a 2-page bulletin on the new **Hauck Agitator For Compound Melting Furnaces.**

According to the bulletin the agitator is composed of four oscillating blades spaced 90° apart, that rotate over an arc of 100°, to assure complete sweeping and cleaning of the entire bottom of the melting pot.

The second page of the bulletin illustrates and describes Hauck's compound melting furnace, hand-type gas torches, and accessories for the compound melting furnace.

Transite Pipe And Couplings

234

Johns-Manville, New York, N. Y., has just published a new 8-page booklet on **Transite Sewer Pipe With Ring-Tite Coupling.**

The booklet illustrates and explains economies which this asbestos-cement pipe can effect in the design, installation, operation and maintenance of a sewer system. It shows how the Ring-Tite coupling makes tight joints more quickly. It covers related items, such as the Transite sewer pipe fittings for connecting to Transite building sewer lines. Also included are tables of sizes, weights and crushing strengths.

Kardex Record Systems

235

Remington Rand, New York, N. Y., has just released a 10-page illustrated brochure that outlines a proved system for handling customer service, truck routings, and invoice accountings, for **LP Gas, Gas, Electric, and Water companies.** The methods described, developed in cooperation with 300 public utility and LP gas companies, afford faster handling of customer requests, improved customer-employee relations, and lower operating costs both in the office and in the field.

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Field Cutter For Asbestos-Cement Pipe

236

Pilot Manufacturing Co., Torrance, Calif., has just released an informative new folder covering the application of its manually operated **Pipe Cutters** for the field cutting of asbestos-cement pipe.

The folder contains data and illustrations on a large cutter which speedily cuts all sizes up to 20-inch nominal pipe size and a junior model which has application on both pressure-pipe and flue-pipe in all sizes through 6 inches.

Drainage And Construction Products

237

Armco Drainage & Metal Products, Inc., Middletown, Ohio, has just issued a condensed illustrated catalog on **Drainage and Construction Products.**

The products discussed in the catalog include: corrugated metal pipe and pipe-arch; Multi-plate pipe; perforated pipe; bin-type retaining walls; tunnel liner plates; Steelox buildings; steel sheeting; Flex-Beam guardrail; the new "Smooth-Flo" corrugated metal sewer pipe; and water control gates.

Steam Cleaners

238

Malsbary Manufacturing Co., Oakland, Calif., has just published a 4-page catalog-in-brief, describing and picturing the entire **Malsbary Steam Cleaner** line.

The catalog tells concisely the difference between high-pressure combination HPC models, steam vapor models, and fireless steam cleaners. It also shows action pictures of each of the eight basic models and suggests where each model fits best. An easy-to-read chart of cleaning actions, pressures, temperatures and capacities completes the catalog.

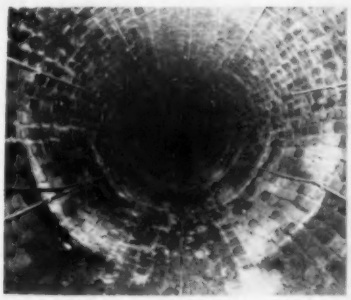
Better Water

239

The General Filter Company, Ames, Iowa, has just published a bulletin entitled **"Better Water."**

The bulletin introduces the company's key personnel, and explains

(Continued on page 110A)



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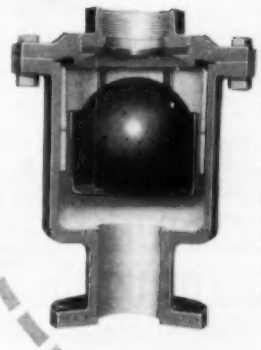

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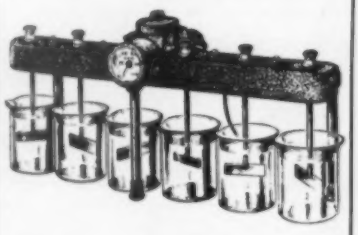

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the company's services and activities. Among the various company services discussed in detail are: the Engineering department; the Research laboratory; Shop construction; and Field construction departments.

Photographs illustrate the company's line of products and show actual installations. The back cover gives a complete list of General Filter's sales offices throughout the United States and Canada.

Wall Chart On Safe Chlorine Handling And Storage

240

Diamond Alkali Company, Cleveland, Ohio, has just issued a wall chart that provides 50 successful suggestions for **Safely Handling and Storing Chlorine** in 100-lb. and 150-lb. cylinders and ton containers.

The chart (17 by 23 inches) is printed in two colors on specially coated, linen-backed stock, tinned on top and bottom with four metal eyelets for convenient hanging on plant walls. It presents safety recommendations covering storage, handling and use of chlorine, and protective practices and equipment. Space is also provided for listing telephone numbers for emergency calls.

Water Clarifiers and Softeners

241

Graver Water Conditioning Co., New York, N. Y., has available a reprint from WATER & SEWAGE WORKS on **Design of Water Clarifiers and Cold Process Softeners.**

The reprint discusses the development of these units and examines the various factors involved in their design and selection. A discussion of the proper rate selection is also included.

Trencher And Backfiller Bulletin

242

The Cleveland Trencher Co., Cleveland, Ohio, has just published a 4-page bulletin on the company's complete line of **Trenchers and Backfillers.**

The bulletin provides readers with a quick, convenient comparison of the capacities, specifications and dimensions of Cleveland's six trencher models and two backfiller models. Text enumerates special design and construction features incorporated in each model. Twenty-seven action photos show the Clevelands at work on all kinds of trenching projects.

Thickeners, Clarifiers And Agitators

243

Hardinge Company, Inc., York, Pa., has just published a completely new, sixteen-page catalog describing their line of **Thickeners, Clarifiers and Agitators.**

The catalog discusses applications and shows construction details for "Auto-Raise" thickeners, circular and rectangular type clarifiers, and agitators.

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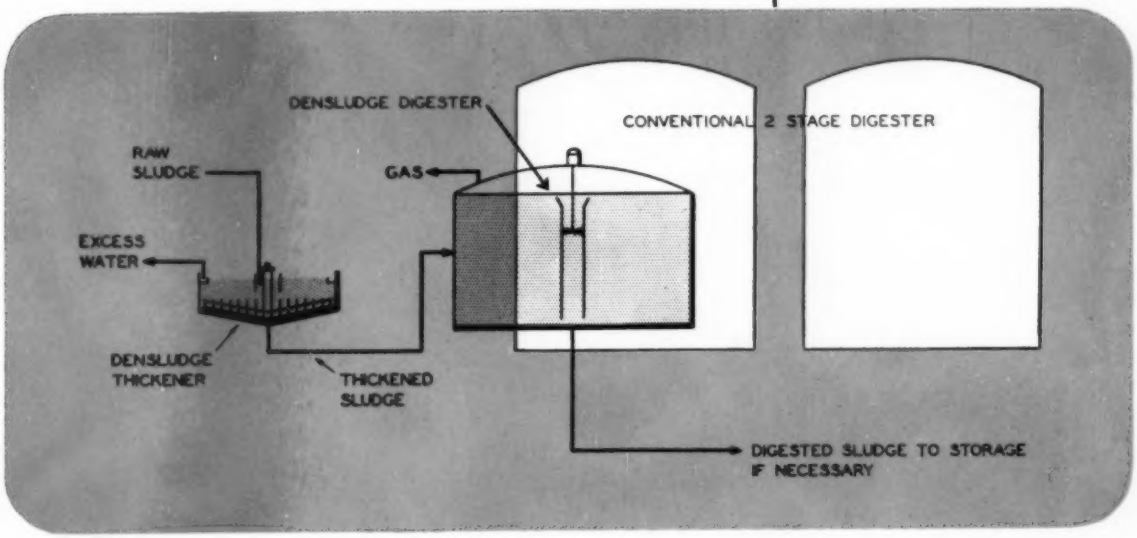

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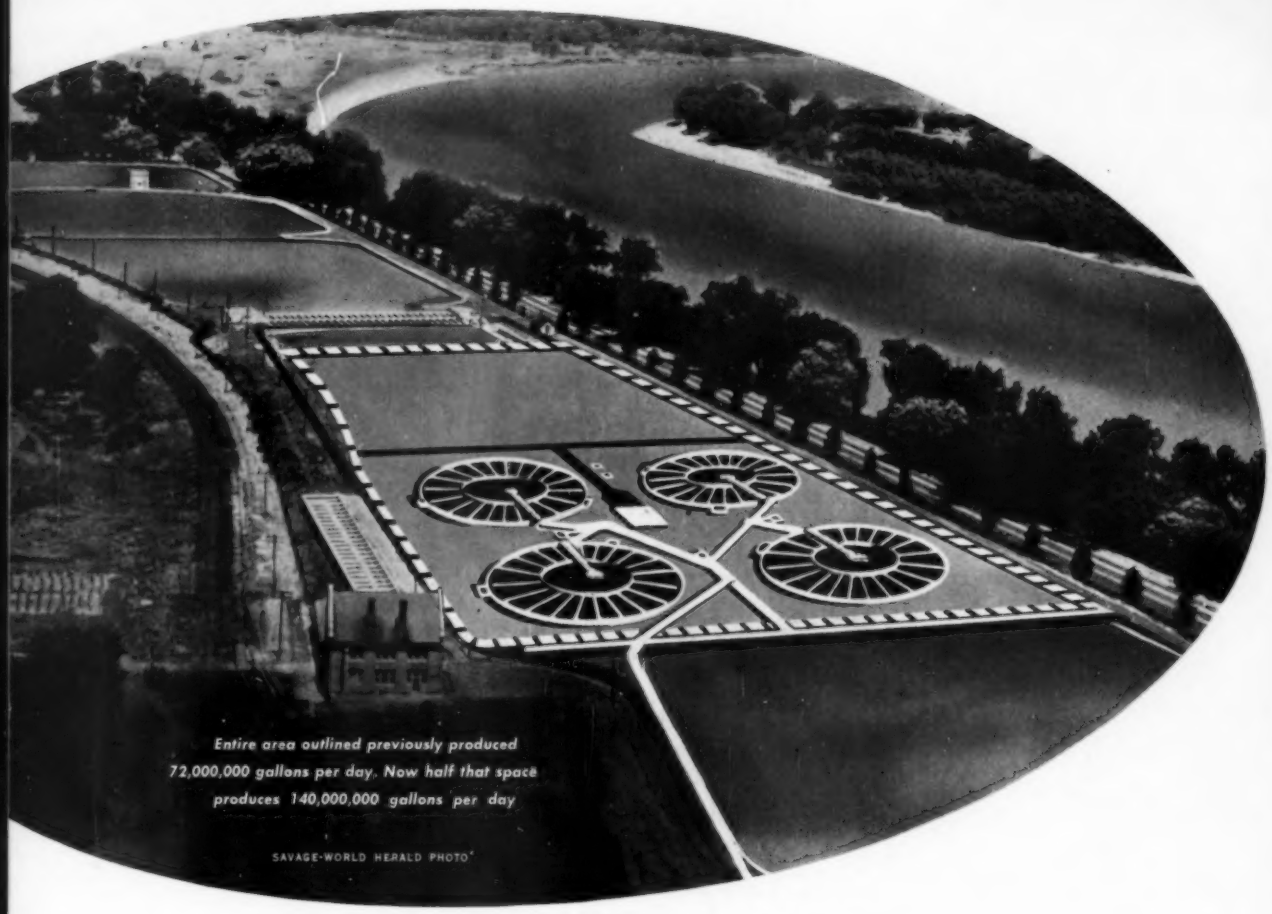

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